ENGINEERING NEWS-RECORD

AUGUST 23, 1945

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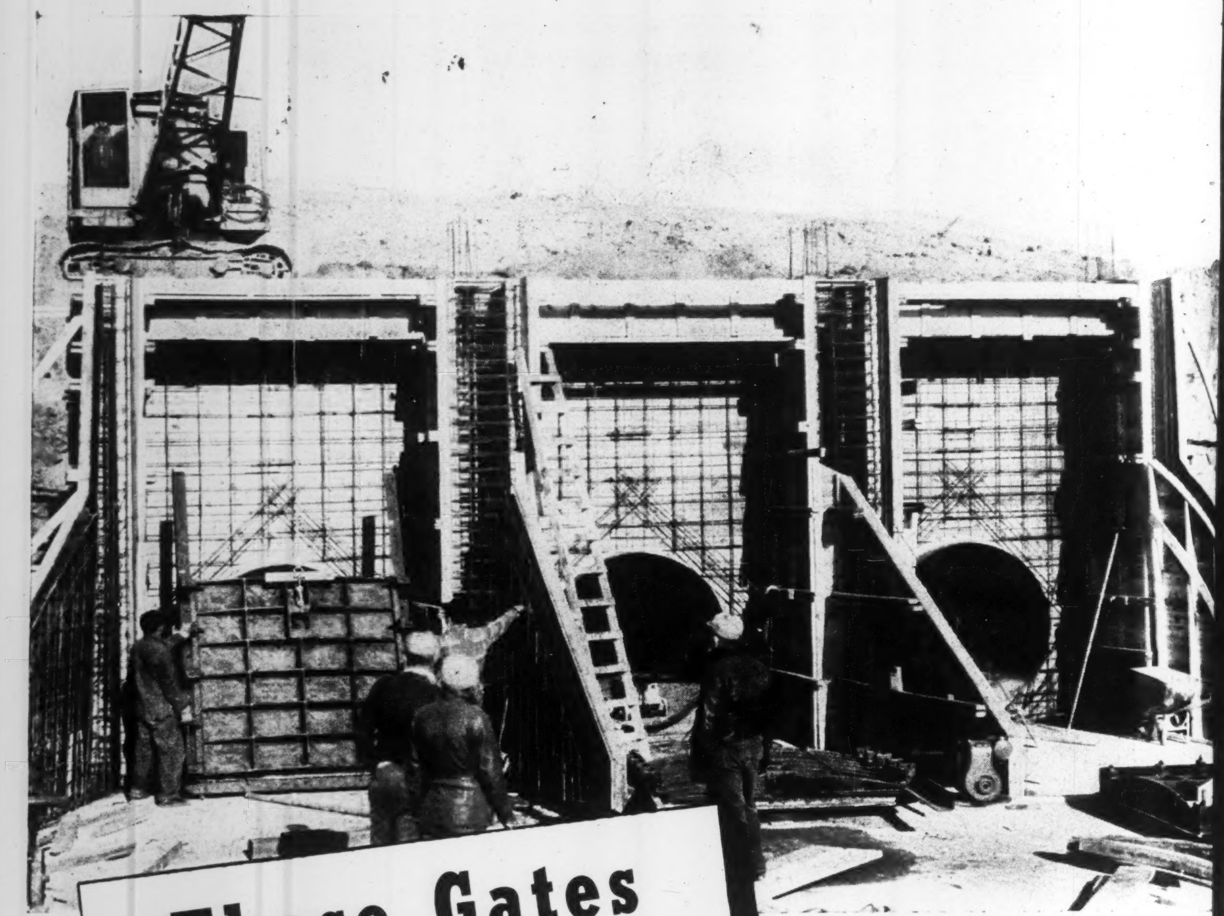
Spetially designed 6-row machine speeds planting of beach-grass at New York's Idlewild airport to prevent soil erosion

In This Issue

SALVAGING A BIG ARMY CANTONMENT

MOISTURE EFFECT ON COMPACTED SOIL



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WALDO G. BOWMAN, *Editor* **ALBERT E. PAXTON,** *Publisher*

Vol. 135 AUGUST 23, 1945 No. 8

COMING NEXT

• In the Sept. 6 issue a special 12-page section devoted to water supply matters will feature articles on an unusual industrial process cooling-water supply and groundwater development on Guam, where "skimming" of underground fresh-water lenses reduces the danger of salt-water infiltration in pervious coral limestone. Another major article presents questions and answers pertinent to Chicago's methods of repairing water meters.

• Construction procedures used in building B-29 plane bases on Tinian Island involved new developments in field methods and administrative control because of the unusual character of the project. The bases had multiple runways 8,500 ft. long and 00 ft. wide, which required removal of 10,000,000 cu.yd. of coral for fills that in some places were more than 0 ft. deep.

• As a result of a first-hand inspection of South American building practices, the conclusion is reached that the methods of construction used by our southern neighbors are not superior to those common in the U. S. Aggregates and mixes are reported to be of only fair quality, whlie the technique of placing concrete is far from perfect. Observations on a number of construction operations that were visited in the course of a special editorial assignment for *ENR* are outlined.

LOOKING AHEAD

• In an early issue will be described the unusual planning of work and scheduling of material that characterized the exacting job of steel erection for the world's largest wind tunnel at Moffett Field, Calif. For setting the steel in place it was necessary to design special traveling stiffleg derricks mounted on high towers, and because of close tolerances in framing the test section and setting the supports for six 0-ft. fans, a careful check of all operations was necessitated.

• Incorporated in the design and construction of a circular reservoir of 4¾-mg. capacity, recently completed at Great Falls, Mont., were new concepts, involving a two-way prestressing technique. This tank has vertical prestressed rods in additional to the customary horizontal bands of prestressed hoops.

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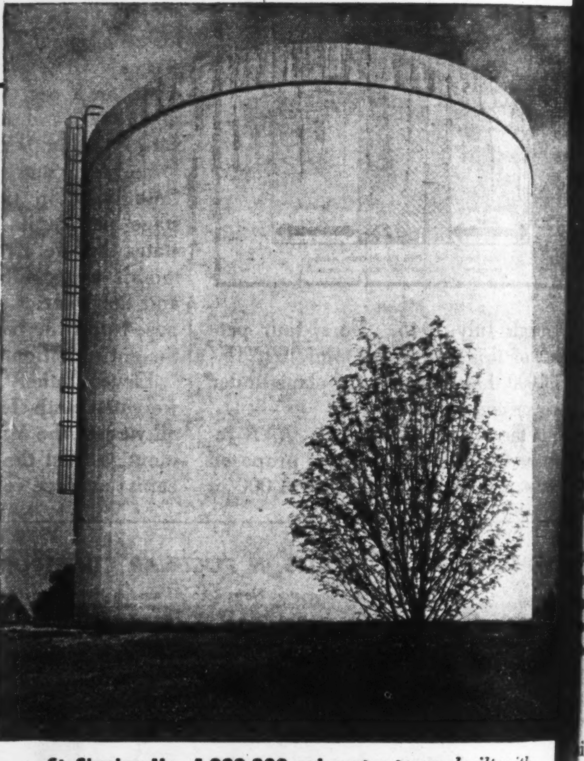

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The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • AUGUST 23, 1945 • VOLUME 135 • NUMBER 8

Industrial construction now freed of all WPB controls

Work permitted to go ahead regardless of cost—One billion dollars of this type of construction expected to materialize in 1946 will be a record volume

To speed up reconversion activities. ndustrial construction projects regardess of cost may now be undertaken ithout War Production Board authorzation, that agency announced on Auust 21. This relaxation is made by ssuing Direction 7 to WPB control L-41. t is in addition to those of last week hich raised the cost ceiling to $100,000 or highway projects permitted to start ithout WPB authorization and which ade major changes in the restrictions n industrial work (*ENR* Aug. 16, vol. . 195).

The new relaxation of building conrols affects construction of factories, lants and other facilities used primarily or manufacturing, processing or asembling of goods or materials. It also ermits work to go ahead on units not rimarily used for industrial work if he construction is to prepare the unit or such work.

In addition, the new direction aproves construction of facilities necesary for handling raw materials or comonents needed in industrial operations r for the distribution of industrial projcts to the retailer.

Permitted types of work

Chief among the types of work conidered as related to manufacturing, rocessing, or assembling, for which Diection 7 now permits construction withut authorization, are:

Mining, smelting and refining, foundries and operations related to extraction of minerals and their conversion to finished form.

Logging and lumbering operations, sawmills, planing mills, and millwork manufacture (but not retail lumber yards).

Pilot plants and industrial research laboratories.

Food processing plants, slaughterhouses, commercial food-freezing plants, commercial cold storage warehouses and food-packing plants, bottling plants, grain elevators, and canneries (but not butcher or grocery stores or frozen-food locker plants serving individual customers).

Textile mills, cotton mills and similar establishments.

Printing and publishing establishments, including those publishing newspapers or printing books, magazines or periodicals.

Retail service establishments serving individual customers are not covered by Direction 7, the WPB points out.

Present WPB estimates for put-in-place industrial construction in 1946 are slightly over one billion dollars. In citing the importance of this huge volume of industrial construction in the reconversion period, the WPB said that annual average volume of put-in-place industrial building in the 1920's was $560,000,000 with a peak of $889,000,000 in 1920. During the 1930's the annual average for this type of work was said to be $250,000,000.

First Friant-Kern Canal contract is awarded

In the vanguard of public projects in California to get War Production Board approval, a contract has been let for the first 5.6-mile section of the 160-mile Friant-Kern Canal, it has been announced by officials of the Bureau of Reclamation. The Peter Kiewit Sons' Co. of San Francisco received the $1,163,340 contract, having submitted the low figure among eleven bidders.

Nearly 1,500,000 acres of land is dependent for irrigation on this canal which runs southward from Friant Dam to its terminus near Bakersfield, serving new and supplemental water to lands on the upper side of the San Joaquin Valley in Fresno, Tulare, Kern and Kings counties.

The Friant-Kern Canal, which will cost about $23,500,000 at 1940 prices, will have a capacity of 4,000 second-feet at the northern end. It will carry a stream of water with a maximum depth of more than 15 ft. and a maximum water surface width of more than 100 ft.

The construction will involve heavy excavation and numerous bridges, siphons, culverts, and other works. About 40 percent of the canal will be concrete-lined. The bureau estimates that about three years will be needed to complete the project and at peak of the work 2,500 men will be employed. When completed the canal will be the longest in California.

Billion-dollar program in N. Y. City

"A public works program creates national wealth. It starts the wheels of prosperity going," said Mayor F. H. La Guardia of New York City in his weekly broadcast Aug. 19. The mayor contrasted New York's readiness in the matter of public works planning with what he claimed was the unpreparedness of the national government in this respect.

Mr. La Guardia said New York City had spent $21,614,000 already on plans, with 28 per cent of the entire program of a billion and a quarter dollars' worth in the complete planning stage covering projects to cost about $331,000,000. He added that 19 per cent of the plans were 50 per cent complete, representing a total expected expenditure of $375,000,000, and that 31 per cent were less than 50 per cent complete, with 21 per cent not yet started.

Direct employment of 100,000 men on these projects would mean jobs for 450,000 men back of the lines in mining, forestry, manufacturing, transportation and other industries, the Mayor estimated. The contemplated projects would require 1,209,951 tons of steel alone.

Prompt action by Congress is needed on many construction bills

Valley authorities, federal aid for airport program, "full employment" bill, and future status of NHA call for early attention

When Congress reconvenes September 5 it will be called upon to act on numerous bills relating to the construction industry. This condition prevails despite the fact that the 79th Congress during its first session enacted a long list of laws related to the industry (See *ENR* Aug. 9, 1945, vol. p. 146).

Of foremost consideration because of the limited amount of money now on hand for civil works construction by the U. S. Army Engineers, the Bureau of Reclamation and other federal agencies, will be the matter of additional appropriations.

A proposal yet to be voted upon and one attracting much attention is the bill (S. 555) creating a Missouri Valley Authority. The Senate Committee on Commerce has already reported unfavorably, and hearings by the Senate Irrigation and Reclamation Committee are to start about October 1. Later the bill will be considered by the Agriculture Committee. As a result, it may be several weeks before a Senate vote occurs.

Several other bills creating river basin authorities, including the Columbia, Arkansas, Potomac, Savannah and Ohio rivers, are also before Congress. The general belief in Washington is that these bills will get little consideration until Congressional work concerning the MVA is completed.

Early action on airports

Committees in both the House and Senate have recommended passage of a bill providing federal aid for a huge airport construction program. The House Committee on Interstate and Foreign Commerce has recommended passage of a bill (H.R. 3615) providing $700,000,000 of federal funds over a 10-yr. period. The Senate Committee on Commerce has reported in favor of a bill (S. 2) making $500,000,000 available in a 5-yr. period. Time will be required to get the two branches of Congress to agree on a common authorization, but passage of compromise bill is assured.

A "full employment" bill (S. 380) also awaits Congressional action and may be considered soon after the recess. Although no federal aid for construction is included in this bill, which is highly controversial in some respects, the part construction is expected to play in the postwar functioning of this measure will be considered.

Another problem facing Congress relates to the postwar role of public housing. Following a Taft committee report that indicated a huge housing program for the first few postwar years, a bill (S. 1342) was recently introduced in the Senate defining the national government's postwar housing functions and making the National Housing Agency a permanent federal organization (See *ENR* Aug. 16, 1945, vol. p. 202, for details).

Minimum wage increases

Before Congress recessed legislation (S. 1282) was introduced amending the Fair Labor Standards Act of 1938 in a manner to increase the minimum hourly wage rate to 65c. Such an amendment would increase the common labor rates on construction in large areas in the South. Although the bill may not be voted on soon, it is expected to receive much support when considered.

Temporarily set aside because it could not be completed in time to aid the war but now expected to come up for early discussion is the question of approval for the St. Lawrence waterway and power development. A bill (H.R. 1428) reviving the 1941 St. Lawrence agreement with Canada was introduced early in the year.

Aid for hospital work proposed

Federal aid to permit local governments to construct adequate hospital, water supply, sanitation, and other health facilities is another matter Congress may take up when it reconvenes. This program is seen by the U. S. Public Health Service as requiring large amounts of construction, much of which will need to be done with federal help (*ENR* Aug. 16, 1945, vol. p. 196).

Congressional authorization for a large hospital program is supplied in a bill (H. R. 1050) introduced in the House early in June. It will provide $50,000,000 of federal aid for hospital construction the first year and $100,000,000 for each of the nine succeeding years. Because of the great demand that construction play a major employment role in the postwar period the bill should receive serious consideration.

Federal aid to provide better water supplies is sought in bills already before both branches of Congress. These bills (H.R. 587 and S. 330) create a division of water pollution control in the U. S. Public Health Service. Still another bill (H.R. 592) provides for water pollution control activity by the Public Health Service. Although similar bills failed to get sufficient support for passage in former sessions of Congress, backing for the present measure is strong.

Other proposals now before Congress and pertaining to the construction industry include: S. 89, providing large amounts for the installation of rural electrification facilities; S. 524, appropriating about $120,000,000 for the acquisition of the necessary land and the construction of numerous military airports; H. R. 2788, establishing a federal statute of limitations and providing a time limit during which the federal government can bring action against a contractor after he has left the job; and S. 469, which provides for financial control of a long list of government corporations, including the Institute of Inter-American Affairs, Export-Import Bank and Defense Plant Corporation.

Release of road funds sought

When Congress passed the first deficiency bill for 1946 it was hoped that the bill would make the first $100,000,000 authorized in the Highway Act of 1944 available immediately, rather than waiting until the President declares the war emergency ended. Although the Senate approved such a move, as finally passed, the bill did not permit this to be done. Congressional authorization may soon be sought.

Although no bill establishing a federal department of public works has been introduced as yet, Congress may be asked to take this action next session. It has been proposed to combine the operations of all such agencies as the Bureau of Reclamation, the National Housing Agency and the Federal Works Agency in one unit. What part Army Engineers would play in such a plan is a question with no easy answer. Nevertheless, the proposal has strong backing and definite action is expected to be taken.

The small amount of money now available to the several federal agencies to go ahead with the large construction programs already authorized may result in the introduction of other important engineering bills (*ENR* Aug. 16, vol. p. 196). For example, the Bureau of Reclamation has only $60,000,000 to start an authorized program of 1.3 billion dollars, while the Corps of Engineers has only $58,000,000 to start construction of a backlog of 4.5 billion dollars of flood control and navigation projects, including nearly 3.5 billion dollars of authorized work.

War housing and Lanham Act projects have been suspended by agencies

National Housing Agency and Federal Works Agency speed plans for eventual disposition of war emergency projects

Awarding of contracts for government-financed war housing under the Federal Public Housing Authority of the National Housing Agency has been brought to a stop and plans speeded for eventual disposition of such housing by a series of orders issued to all regional offices by Philip M. Klutznick, FPHA Commissioner.

Award of any new contracts or authorizations to start construction on new war housing projects were stopped until further notice.

Projects under construction are to be reviewed to determine where savings can be effected by suspending further operations.

Management expenditures are to be reduced to minimum needs pending further instructions, and items such as operating improvements, repairs, and additional facilities are to be suspended except where urgently needed to protect health and safety of tenants.

Regions were instructed to speed up recommendations to place projects in stand-by or terminated status as war occupancy need diminish, and to proceed immediately with plans for eventual disposition of war housing in cooperation with regional representatives of NHA and with local communities.

The regions were also instructed to review all low-rent projects deferred by the war to determine how soon they can be built as part of the reconversion program to resume peacetime production and employment.

Mr. Klutznick pointed out that although new war housing contracts have been stopped pending further determination of need, occupancy of war housing by workers will necessarily continue for some time, and under the recent amendment to the Lanham war housing act, such housing is also to be used for distressed families of veterans and service men. Any further construction or reuse of such housing will be resumed on the basis of needs reviewed and determined by the National Housing Administrator.

Lanham Act cancellations

Projects under the Lanham Act financed entirely by federal funds and not actually under construction, even though contracts have been awarded, are to be suspended immediately pending action to rescind the allotments. Such projects under construction may continue either to completion or completion of a useful unit if it can be shown that the need for the facility still exists.

With respect to non-federal construction projects for which allotments have been made but for which contracts have not been approved, the allotments will be rescinded. Non-federal projects are those for which the federal government has contributed a portion of the cost.

The Federal Works Agency will continue to recommend allotments from available Lanham Act funds for assistance in the maintenance and operation of schools during the present school year in the same manner as such allotments have been approved in the past to meet current operating deficits.

FWA also will continue to make allotments on projects already approved for the operation of general hospitals, recreation programs for service men and miscellaneous municipal service projects until October 31, 1945.

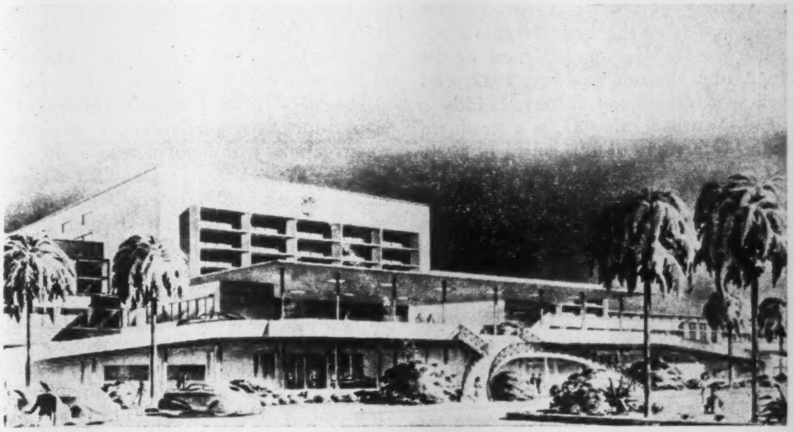
Since Lanham Act assistance for child care and civilian recreation was based on recruitment of workers for war production, this assistance will be terminated as soon as possible, but not later than October 31, 1945.

In making the announcement, General Philip B. Fleming, Federal Works Administrator, said: "It must be remembered that activities authorized under the Lanham Act were war activities to meet war needs and were not applicable as reconversion measures."

While Lanham Act assistance will soon be terminated due to the cessation of hostilities, General Fleming pointed out that the Bureau of Community Facilities of the Federal Works Agency was expanding its advance planning program to assist States and local governments in the preparation of plans for needed public works.

◆

Relocation of a 9-mile stretch of U. S. Highway 101 north of Santa Barbara, Calif., estimated to cost $1,000,000 has been approved as an immediate postwar project, it was announced recently by L. H. Gibson, Santa Barbara district engineer for the State Division of Highways. The new section will bypass the Goleta Marine Corps Air Station.



Work to start at once on $7,000,000 Panama airport

Indication of Panama's importance in postwar aviation is seen in the recent announcement that construction is to be started immediately on a new $7,000,000 airport in Panama.

Leon P. O'Connor, Vice-President and General Manager of F. H. McGraw & Co. of Panama, engineers and constructors, to whom the contract for the engineering and architectural design of the airport was let by the Republic of Panama, stated that the new air terminal would be capable of accommodating planes half again the size of the B-29 superfortress. Planes of this size, with a 300,000 pound total gross load, are already planned for Pan American World Airways, Inc.

The Panama Airport is to be designed to accommodate all types of heavy airplanes. The 2-story reinforced concrete terminal, 625 feet long and containing approximately 300,000 square feet of space, the administration building of which is pictured above, is to be air conditioned and will include restaurants, observation terraces and maintenance shops. It will feature all the latest innovations in passenger convenience, engineering skill and operating efficiency to be expected in peacetime.

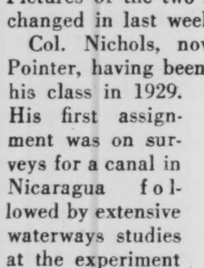
Atomic plant building directed by young men

Col. K. D. Nichols, district engineer for the Manhattan Engineer District in charge of the large construction program for atomic bombs, and Col. F. T. Matthias, area engineer at Hanford Engineer Works, are both relatively young men who have risen rapidly in the Army. The entire program has cost $1,665,000,000, of which $1,106,000,000 was spent at Clinton under Col. Nichols' direct observation while work at Hanford under Col. Matthias cost $382,000,000. Pictures of the two officers were interchanged in last week's issue.

Col. Nichols, now 37, is a West Pointer, having been graduated fifth in his class in 1929. His first assignment was on surveys for a canal in Nicaragua followed by extensive waterways studies at the experiment station at Vicksburg and obtaining a Ph.D. in experimental hydraulics from the University of Iowa. Col. Nichols taught at West Point from 1937 to 1941, then was area engineer on construction of the Rome, N. Y., Air Depot and later the Pennsylvania Ordnance Works. He was assigned to the Manhattan District in June, 1942, and became a full colonel in May, 1943.

Col. Nichols

Col. Matthias, also 37, is a graduate of the University of Wisconsin in 1930. He served on the engineering faculty there, then went with the Tennessee Valley Authority where he worked on construction and design of temporary plant. In 1939 he was associated with Al Johnson Construction Co. and later with the Dravo Corp. During this time Matthias held a reserve commission in the Army and reported for duty, in April 1941, as a first lieutenant. He worked under General Groves on construction of the Pentagon and then on ports and supply depots of the construction division of the Chief of Engineers office before being assigned to the atomic project.



Col. Matthias

Maj. Gen. Leslie R. Groves, in charge of all phases of the atomic bomb project, is only 48. He is a West Pointer and an Army "career" man with widely diversified experience on many classes of construction.

Normal bidding resumed by Corps

With the resumption of the civil works program of flood control and river and harbor improvements by the Corps of Engineers, the general policy of formal advertising for and public opening of bids followed before the war in awarding civil works construction contracts will be resumed, Lt. Gen. Eugene Reybold, Chief of Engineers has announced.

During the war only those civil works projects deemed essential to the war effort were continued by the Corps of Engineers. Contracts for these projects were negotiated on the same basis as military construction contracts (*ENR* July 26, vol. p. 85).

Road and R.R. relocations for 7 northwestern dams

Col. Ralph A. Tudor, of the Portland district Army Engineers, has announced that the Umatilla Rapids Dam on the Columbia River and six Willamette Valley dams in Oregon, on which the Portland district engineers plan to start construction by the end of 1946, will necessitate relocation of 109.4 miles of highway and 190.7 miles of railroad.

The $87,226,000 Umatilla (McNary) Dam, which is scheduled for the earliest construction, will involve relocation of 87 miles of Spokane, Portland & Seattle, Union Pacific and Northern Pacific railroad tracks; 72 miles of Oregon state highway; 14 miles of Washington state highway, and 20 miles of county roads.

The $23,047,000 Detroit Dam, which will be one of the first Willamette Valley projects, with bids expected to be called in the summer of 1946, will entail relocation of 18.5 miles of the North Santiam highway from Gates to 1.5 miles east of Detroit, Ore.

The $25,470,000 Meridian Dam on the middle fork of the Willamette River, scheduled for bidding late in 1946, will require relocation of 22.7 miles of Southern Pacific railroad; 12.9 miles of Oregon state highway No. 58; 14 miles of forest service roads, and 1.8 miles of county roads.

Although surveys have not been completed on relocations necessitated by the proposed dam on the Columbia at The Dalles, preliminary estimates show relocations of 45 miles of S. P. & S. railroad; 36 miles of Union Pacific line; 19 miles of highway U. S. 30, and 2 miles of county roads.

Culvert firms indicted as antitrust violators

Six corporations and seven of their officers have been indicted by a federal grand jury at Seattle, Wash., for violations of antitrust laws in the fabrication, sale and distribution of metal culverts.

The defendant companies are: Washington Culvert and Pipe Co., Seattle, Wash.; Oregon Culvert and Pipe Co., Portland, Ore.; California Corrugated Culvert Co., Berkeley, Calif.; Hydraulic Supply Manufacturing Co., Seattle, Wash.; Collins Concrete and Steel Pipe Co., Portland, Ore., and Beall Pipe and Tank Corporation. The R. Hardesty Manufacturing Co., a Colorado firm, dissolved in 1942, was named as a co-conspirator.

Hardesty, Washington, Oregon and California Culvert are all wholly owned subsidiaries of the American Rolling Mill Co., Middletown, Ohio.

The indictment was in two counts, one alleging price-fixing and the other charging conspiracy to monopolize. It was said that various agencies of the federal government had been forced to purchase their metal culverts in the states of Washington, Oregon and Idaho, where metal fabricating plants are operated only by the defendants, without the benefit of competitive bidding and at high and artificial prices.

. . .

Union truck terminal to be built near Newark

Construction of a $2,600,000 union motor truck terminal in the Newark N. J. area by the Port of New York Authority has been recommended by its Port Planning Committee to expedite freight movement and to hold down shipping costs.

Asserting that it would be the largest truck terminal in northern New Jersey, Vice Chairman Joseph M. Byrne Jr. said that construction would be rushed soon after the authority approves, probably next month. The committee's action was based on findings developed at a public hearing in May at which Governor Walter E. Edge of New Jersey and Governor Thomas E. Dewey of New York endorsed the project along with sixty-one of sixty-four groups in the trucking and associated industries.

The committee suggested the acquisition of twenty-five acres east of Frelinghuysen Avenue and Broad Street and south of the Passaic River as the terminal site. It will be operated by the Authority and will bring economies in truck transport of between $288,000 and $432,000 a year, Mr. Byrne said.

New Pittsburgh airport greatly enlarged

The site of Greater Pittsburgh Airport west of Pittsburgh, Pa., in Moon Township has been increased from 1129 to 1500 acres. It will be nearly three times the size of La Guardia Field in New York.

The total cost of the expanded airport will be $25,000,000. The present two 5,500-foot runways will be increased to 9,600 and 6,300 feet, and two additional runways will be added eventually.

Almost unlimited expansion of the Greater Pittsburgh Airport is being provided for, said Allegheny County Commissioner John J. Kane.

Revised plans call for 31 loading gates, 29,500 feet of taxiing strips 75 feet wide; six 200x300-foot hangars; three two-story airline docks, 80x600 feet; kitchen to accommodate 3,000 employees; parking space for 8,400 cars.

A proposed highway from the airport to downtown Pittsburgh will have a cloverleaf at Montour Railroad, Cliff Mine and Beaver Grade Roads, and another cloverleaf to join U. S. 22-30. New route of 15.8 miles will permit driving to downtown Pittsburgh in 25 minutes.

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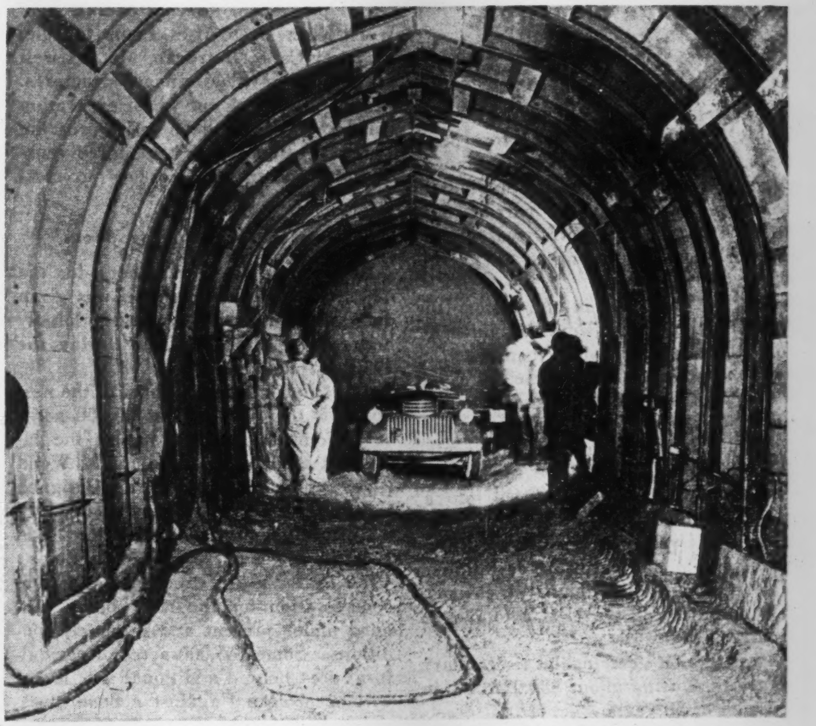

Conchas Canal tunnels nearing completion

With the first 38 miles of its 75-mile length already in operation, the partially completed Tucumcari irrigation project in New Mexico is progressing rapidly. The system will irrigate 45,000 acres of land.

Workmen above are installing liners in a section of one of the four tunnels in the first 38-mile stretch of the canal, carrying water from Conchas Dam to a point near Tucumcari.

Most difficult section of the $8,155,000 project, this section crosses numerous arroyos and traverses the foot of steep slopes that have forced construction of 23 siphons and four tunnels. The canal has a capacity of 700 cu.ft. per sec. through the first 38 miles.

Ordnance cancellations by Corps of Engineers

A total of $218,063,000 of industrial contracts was cancelled on Aug. 14 by the Industrial Construction Division. Corps of Engineers, the total estimated cost of the work not completed being $50,382,000.

Among the larger projects cancelled, with the estimated cost of uncompleted portion, are the following:

Badger Ordnance Works, Merrimac, Wis., $767,634.

Buckeye Ordnance Works, South Point, Ohio, $278,357.

Cactus Ordnance Works, Dumas, Tex., $76,518.

Chevrolet Shell Plant, St. Louis, Mo., $56,800.

Firestone Truck Rim Project, Cambridge, Ohio, $412,200.

Gopher Ordnance Works, Rosemount, Minn., $103,926.

Hoosier Ordnance Plant, Charleston, Ind., $302,905.

Indiana Ordnance Works, Charlestown, Ind., $27,580,038.

Jefferson Proving Ground, Madison, Ind., $651,430.

Kankakee Ordnance Works, Joliet, Ill., $438,881.

Kingsbury Ordnance Plant, La Porte, Ind., $257,852.

Pine Bluff Arsenal, Pine Bluff, Ark., $1,550,000.

Radford Ordnance Works, Radford, Va., $8,939,070.

Redstone Arsenal, Huntsville, Ala., $245,182.

Sunflower Ordnance Works, $1,519,800.

Volunteer Ordnance Works, Chattanooga, Tenn., $580,000.

Weldon Spring Ordnance Works, Weldon Spring, Mo., $2,503,744.

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Third contract awarded on San Diego Aqueduct

The Navy has awarded the third in a series of seven contracts for construction of the 71½ mile, $11,356,000 emergency aqueduct to bring Colorado River water to San Diego, Calif. The contract is for construction of 25½ miles of pipe and structures on the southern end of the aqueduct and was awarded to the S. A. Healy Co. of Chicago, Ill., for $2,597,344.

First two contracts were awarded in July (*ENR*, July 26 '45, vol. p. 90). Bids for the remaining four tunnels and the building of San Jacinto reservoir and the short pipeline connecting the reservoir to the West Portal tap into the Colorado River aqueduct were scheduled to be received soon.

Reports from the Navy indicate that bids are being awarded on schedule and that officials are satisfied with prices asked. Initial earth-breaking ceremonies are expected to be held in October, although pipe construction already has begun, and it is expected that the project will be completed within two years. Difficulties in obtaining steel and experienced tunnel workers may cause a possible delay in actual construction until November.

Capt. Alden K. Fogg, CEC, USN, Eleventh Naval District Public Works Officer, is supervising construction, while Comdr. Robert D. Thorson, CEC, USNR, is resident officer in charge. Three Navy officers, including Thorson, are working on preliminary details in the field from Vista, Calif.

Long-range plans for Puerto Rican highways

The Planning Board of Puerto Rico has recommended to the legislative assembly and the governor, a large program for the construction, maintenance and repair of highways and municipal roads and bridges, to be carried out during a period of 25 to 50 years, with appropriations amounting to $147,588,000.

For the first time in the history of Puerto Rican public works administration, it has been possible to prepare a complete program to meet the more urgent demands for public highway, roads and bridges, regulating the investment of public funds as they become available. The plan involves the repair and expansion of existing facilities into a system of modern thoroughfares. Details of this vast program, as approved by the Planning Board, are as follows:

Construction of principal highways, in a period of 35 years, at a total cost of $51,987,000.

Construction of insular secondary highways, costing about $34,972,000, in a period of 50 years.

Construction of municipal roads, during a period of 25 years, with an investment of $9,018,000.

The total construction would increase the available paved surface to 3,600 miles. Puerto Rico now has about 2,010 miles of roads and principal highways.

According to the proposed program, it is estimated that in 1970 there will be 60,000 motor vehicles registered in Puerto Rico. In 1942, the total number of motor vehicles registered was 32,000. Trust funds, made up of gasoline taxes and motor vehicle licenses, amounted to $4,500,000 in 1942. It is estimated that trust funds in 1970 will reach the amount of $9,000,000.

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Large levee program begun near St. Louis

Following the recent removal of War Production Board restrictions on manpower and materials for river improvement, the U. S. Army Engineers have started work on a huge levee construction program along the Mississippi River in the vicinity of St. Louis. Funds amounting to $12,671,000 have been allotted to the program which is estimated to cost some $25,000,000. Funds for this improvement had been allotted originally by the Chief of Engineers, U. S. Army, under the Flood Control Acts of 1936 and 1938 but work was suspended while in its initial stage due to the war emergency.

The program will involve about 200 mi. of permanent levee extending from Wood River, north of St. Louis, to Gale, Ill., near Cape Girardeau, Mo., as well as a number of drainage structures. Nearly 70,000,000 cu. yd. of excavation will be required for the entire program which is estimated to take three years of good construction seasons to complete.

Designed for maximum floods

In determining levee grades for the new work, full consideration was given data secured from the exceptionally high water which occurred during the 1943 and 1944 floods.

The chief function of three of the new levees is to protect about 85,000 acres of agricultural land including the industrial areas of East St. Louis, Wood River and Dupo, Ill. They are designed to afford protection against a flood of the magnitude of that which occurred in 1844 (greatest on record at St. Louis) allowing for a 2-ft. freeboard with due consideration for the river being confined under present and proposed conditions. Some 165,000 acres of agricultural area behind additional new levees will be protected against a flood of estimated frequency of once in fifty years, plus a 2-ft. freeboard.

Two contracts under way

The first two contracts for levee construction under this program were awarded during July and work on them now is under way. One covers a section of the Columbia drainage area while the other includes the new Clear Creek levee. Additional contracts will be negotiated as rapidly as designs can be completed and right-of-way furnished by local interests in accordance with a schedule designed to accelerate construction.

Funds authorized for current and proposed levee construction have been allocated to the several levee districts as follows:

Clear Creek	$1,589,000
Wood River	2,495,000
Harrisonville and Ivy Landing	2,349,000
Prairie Du Pont	831,000
Columbia	420,000
Preston	1,210,000
Grand Tower	89,000
Fort Chartres and Ivy Landing	414,000
Stringtown and Ivy Landing	731,000
Degognia and Fountain Bluff	2,543,000
	$12,671,000

All levee construction and improvements are under the direct supervision of Col. L. B. Feagin, district engineer, and Lt. Col. Walter F. Lawlor, chief of engineering division, St. Louis District, reporting to Col. Malcolm Elliott, division engineer, Upper Mississippi Valley Division, U. S. Army Engineers.

◆

The Massachusetts Legislative Committee on Highways and Motor Vehicles has approved a six-year postwar highway program totaling $178,521,000. It is said that the whole project can be financed by the state gasoline tax revenue and Federal funds without additional levies. Completion of the program would still leave from $15,000,000 to $25,000,000 in free cash in the highway fund, according to estimates.

JOBS OF THE WEEK

HYDRAULIC FILL AT AIRPORT, Idlewild, N. Y.

Atlantic, Gulf & Pacific Co., New York, N. Y., has been awarded a contract for hydraulic fill at Idlewild Airport by the Department Marine & Aviation, New York, N. Y., at $3,088,453. Jay Downer, New York, N. Y., is consulting engineer.

IMPROVING CATAPULT, Patuxent River, Md.

Bureau of Yards & Docks, Navy Department, Arlington, Va., received the low bid for improving catapult at Naval Air Training Station from C. J. Langenfelder & Son, Washington, D. C., at $1,319,820.

HOSPITAL, Reno, Nev.

Robert E. McKee, Glendale, Calif., has been awarded a contract for main building, roads, and walks at Veterans Hospital by Bureau of Yards & Docks, Navy Department, Washington, D. C., at $1,353,000.

ROADS, Illinois.

Division Highways, Department Public Works and Buildings, Springfield, Ill., received low bids for improving Federal aid route 13, Lawrence Co., from S. J. Groves & Sons Co., Minneapolis, Minn., $684,596; combination of same road Sections 2-2 and 3-2 from Cameron Joyce & Co., Keokuk, Ia., at $1,086,597; road F. A. 5, Sections 18R, 17R-1, McLean Co., from I. D. Lain Co., Springfield, $587,322.

Note—Additional bidding and contract news on many projects large and small, including the above items, appear in the Construction News section beginning on page 183.

OBITUARY

Thomas D. Potwin, president of the Washington State Reclamation Association, died July 27 in Seattle. A resident of Yakima, Wash., Mr. Potwin was in Seattle to address the annual Institute of Government at the University of Washington on the proposed Columbia Valley Authority bill, which he opposed.

Fred Barker, 58, a construction engineer for the Krumroy Construction Co., Akron, Ohio, for 25 years, died Aug. 6 in Cuyahoga Falls.

Wayne D. Trewhitt, 82, co-founder of the general contracting firm of Trewhitt-Shields & Fisher, and a resident of Hanford, Calif., for 57 years, died Aug. 7. He was in the contracting business until his retirement in 1930.

John F. Geoghegan, 68, contracting manager of the American Bridge Co., New York, died Aug. 6. Mr. Geoghegan was employed by the Berlin Iron Bridge Co. of Berlin, Conn., shortly before it became a branch of the American Bridge Co. He represented the American Bridge Co. in some of its large bridge and building undertakings in New England and New York State.

Samuel F. Hornbeck, 38, civil engineer, died in Los Angeles, Calif., Aug. 5.

Michael J. Sasgen, Chicago, engineer and president of the Sasgen Derrick Co., died recently. He was an inventor and manufacturer of industrial equipment.

Lt. Chester H. Tucker, 32, interned by the Japanese since the fall of Corregidor, was killed when a prisoner of war ship was torpedoed and sunk in Subic Bay, Luzon, according to belated word received by his parents in Minneapolis, Minn. He entered the Army in 1940 after a year's service at Ft. McKinley, Me. He was a graduate of the University of Minnesota school of engineering.

Rufus A. Doughton, 88, Sparta, North Carolina, died August 17. Mr. Doughton served as District Highway Commissioner for many years, and also was Chairman of the North Carolina State Highway & Public Works Commission, Raleigh, N. C.

Ralph D. Merrill, 51, contractor of Helena, Mont., died Aug. 4 at Missoula. He operated the R. D. Merrill Construction Co., which held government contracts in Utah, Idaho, Nevada, Montana and Washington.

Isadore S. White, 51, contractor, builder and owner of the Century Improvement Co. of Houston, Tex., died July 30.

Bernhard A. Froemming, 43, a public works contractor and head of the Froemming shipyards, died August 15 in Milwaukee, Wis.

Donald Grant McKim, 58, of Houston, Tex., a state highway department civil engineer for 20 years, died July 30.

Frank Bonner Stratford, 76, civil engineer of Highlands, Tex., died Aug. 12. Mr. Stratford was Federal Works Administration civil engineer on the San Jacinto River pumping plant and industrial water canals project at Houston when he retired in May. He had served as civil engineer for the San Jacinto Rice Co. of Beaumont, and Tyrell and Garth of Highlands.

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Philip Harrington heads Chicago Transit Board

Philip Harrington, commissioner of Subways and Superhighways, Chicago, since 1938, has resigned that office to accept the chairmanship of a recently appointed seven-man Chicago Transit Board which will direct operations of the Chicago Transit Authority. Established by an act of the 1945 Illinois state legislature and approved by a 6 to 1 referendum vote of the citizens of Chicago last June, the Transit Authority provides for the acquisition and operation of Chicago's transportation facilities under one unified system (*ENR* April 12, vol. p. 544).

Mr. Harrington has had long experience with Chicago engineering activities. His engineering training includes a Bachelor of Science degree in Electrical Engineering from Armour Institute in 1906, a Bachelor of Laws degree from Kent College of Law night school in 1915, and an honorary degree of Doctor of Engineering from Illinois Institute of Technology in 1944.

Mr. Harrington spent 29 years with the Sanitary District of Chicago, starting as rodman in 1906 and advancing progressively through several positions to that of assistant chief engineer in 1924 and to the office of chief engineer in 1933. While serving as chief engineer of the Sanitary District he was the co-inventor of a method for the mechanical dewatering and incineration of sewage sludge with auxiliary waste-heat power generation.

In 1935, Mr. Harrington resigned to accept the post of transit advisor to Chicago in improving local transportation and traffic conditions. In this capacity he presented, in 1937, "A Comprehensive Transportation Plan for Chicago."

This report recommended definite plans for an initial system of subways, a definite program for unification and modernization of all transportation facilities and the preparation of a comprehensive superhighway plan for the city. As a direct result of this study and report, action was taken leading to the construction of Chicago's present State Street subway which was completed in October, 1943 (*ENR* Oct. 21, 1943, vol. p. 598).

On Plan Commission

Mr. Harrington is a member of the Chicago Plan Commission and also serves as chairman of the Engineering Board of Review. This board is charged with the duty of reviewing and recommending all postwar public works in Chicago. During the period of Civilian Defense activities he served as chief of communications, and directed the installation, operation and maintenance of Chicago's air-raid warning system of communication.

Since its inception, Mr. Harrington has been local administrator of the Office of Defense Transportation, and, in this capacity, had the responsibility for the war-time conservation of local transit vehicles, the necessary re-routing of transit lines, the staggering of working hours, and the organization of group riding among war workers to save transportation.

Other Board Members

Other members of the seven-man board directing the Chicago Transit Authority are: John Quincy Adams, vice president, Continental-Illinois National Bank and Trust Co., Philip W. Collins, formerly director of the Illinois State Department of Revenue; George F. Getz, jr., president, Globe Corporation; William W. McKenna, attorney; Irvin L. Porter, vice president, First National Bank; and James R. Quinn, former alderman and chairman of the Council Committee on Local Transportation.

Mr. Porter is treasurer of the board and Mr. McKenna is its secretary. Board members each receive an annual salary of $15,000, except the chairman whose salary is $25,000 per year.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Remedy for Spillway Erosion

Sir: Erosion due to cavitation, as described in *ENR* (March 8, 1945, vol. p. 33), for the Bonneville Dam, was experienced very soon after the earliest application of large Stoney gates on spillways. An effective remedy was used more than forty years ago.

The progenitor of the Bonneville gates was designed by Lionel Bury Wells for a dam near Manchester, England, in the year 1883. A second type of roller gate was patented by F. G. Stoney and built in Brazil, India and Ireland as early as 1884. Soon thereafter, notable installations of that type were built in the United States at Sault Ste. Marie, Lockport, Buffalo, Laguna, etc.

The rapid development of hydroelectric power in the nineties necessitated the use of large spillway gates. In the year 1886, Stoney designed the gates for the Chevres Dam, a municipal power dam for the city of Geneva, Switzerland. These gates have a clear opening of 32.8 by 28 ft. Erosion, due to turbulence and cavitation in the gate grooves, soon made extensive repair necessary. The original installation is shown in Fig. 1; changes were made as shown in Fig. 2. Cast iron shields were fastened to the pier faces in order to direct the turbulent flow away from the gate grooves. This proved entirely successful, but necessarily reduced the gate opening.

Similar experiences were recorded at the spillway gates of other installations in France and Switzerland, such as Albula (Fig. 3), Leuk (Fig. 4), Tuiliere and Hagneck. The same remedy was successfully applied. At the Aue Dam the same result was obtained by a suitable form of the pier (Fig. 5). At the Augst-Wyhlen Dam on the Rhine (Fig. 6) the required protection was obtained by the pier design as shown. Since then no cavitation troubles have been encountered (Transactions Vol. IX, World Power Conference, Berlin, 1930).

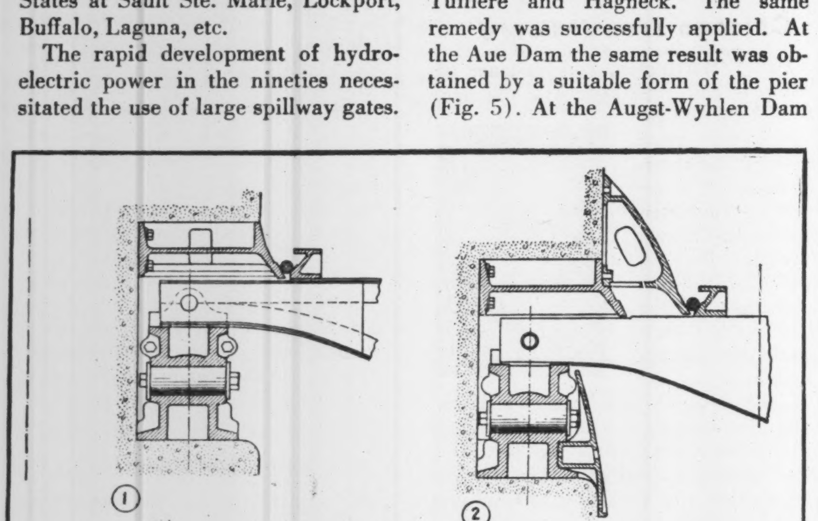

Fig. 1 to 6. Erosion due to cavitation in the vicinity of gates on dam spillways can be avoided either by installing shields to divert turbulent flow away from gates grooves (Fig. 1 to 4) or by proper design of pier (Fig. 5 and 6).

Some of the largest truck-type gate installations were built on the Rhine in Switzerland at Laufenburg in 1907, having gates of 56.7 by 52.5 ft. clear openings, and at Ryburg in 1927 having a clear opening of 39.4 by 78.8 ft. The latter have a so-called "hook-gate" for the upper part. The hook-gate can be lowered to serve as an overflow weir, thus avoiding continuous spilling over the gate sill at high velocities and under conditions favorable to cavitation.

The accompanying sketches were taken from a publication of the late K. E. Hilgard, noted Swiss engineer.

ABRAHAM STREIFF
Jackson, Mich.

Bypassing the Sheepskin

Sir: Your timely editorial "Bypassing the Sheepskin" in (*ENR* March 22, vol. p. 376,) raises many significant questions. The demand for courses in engineering techniques at a subprofessional level comes at a time when engineering colleges throughout the country are planning on strengthening their regular courses in professional engineering. The subprofessional courses are training courses, while it is hoped that the professional courses may provide an educational base for advancing the profession. There is a wide difference between the philosophy of the two types of courses.

Nearly all subprofessional programs include courses in design or specialization before the student has an adequate background in mathematics, natural sciences and engineering. Such courses without an adequate base can teach for the most part only the "how" and not the "why". If the "how" is taught well and happens to represent current practice, the student is immediately useful to his employer. Under present conditions, the "how" does not remain the "how" long. To advance with science—to keep up with practice—to penetrate the unknown—means that the "why" must be understood.

Your editorial suggests that if a man studies these courses, and these courses alone, he will be able, in most states, to pass the examinations for license as a professional engineer. It is hoped that this is not true, for if it is true, the main reason for licensing engineers has been forgotten. The strongest argument for registration of engineers was that it would keep engineering design in the hands of qualified men. If great numbers of poorly prepared men—no matter what the form of their preparation—enter the profession, serious conditions will result. There has been a great deal of discussion lately concerning the obsolescence of specifications for buildings and many cities are revising their antiquated codes to take care of advances in science, materials, and practice. After such revisions, haphazard applications of formulas and rules without an understanding of their limitations will be a decidedly serious matter.

It is believed that employers know what they can expect of graduates from subprofessional courses. While it is true that the employer needs men of limited training for certain jobs, he himself, in most instances, can provide this training better than any school. It is hoped that the employer is aware that professionally trained men will ultimately be of the greatest usefulness to him. The employer must depend on such men to forward his interests and keep him abreast of modern materials, design and methods. Not all employers, however, take this long-run view, and consequently the answer is YES to your last question, "Will inclusion of so much engineering in a subprofessional course not work to the disadvantage of men willing to spend time and money on building a broader base for an engineering career?"

Few contractors and fewer engineering employers realize that in the last two decades the enrollment in civil engineering courses in our engineering colleges has been drastically reduced. This, of course, has been brought about by many factors; but one for which the employers have been mainly responsible has been the lack of jobs for the graduate. The employer, in many instances, has hired men of limited background, thus filling positions normally taken by graduates as their first step into the profession. As a consequence, the chances for a good job with opportunities for advancement have decreased and the civil engineering profession in general eventually will suffer.

In conclusion, we would point out that if the employers of graduates in engineering want the subprofessionally trained man to the exclusion of all others, and if building codes remain out-of-date, and if practice fails to keep up with scientific developments, then subprofessional training will be in great demand. If that happens, the engineer will not contribute in any large measure to the developments and applications of science.

SCOTT B. LILLY, *Chairman*
Division of Engineering
SAMUEL T. CARPENTER
Associate Professor
of Civil Engineering
Swarthmore College, Pa.

Jet Disperser Not New

Sir: The article on Fontana Dam (*ENR*, Nov. 16, 1944, vol. p. 633) implied that the type of jet disperser adopted for the dam has so far only been proven in laboratory experiments.

It may be of interest to readers of *ENR* to know that I developed this type of disperser in 1922 when employed as manager of the hydroelectric department of Messrs. J. Blackeborough & Sons, hydraulic engineers, of Bridgehouse, England.

The first one made was developed from a very small model made of brass; the prototype was made of cast iron and is installed at the Shongweni Dam of the Durban water works in South Africa, shown in the photo.

The disperser is bolted to the downstream flange of a Larner-Johnson, Type N, discharge regulator, the outlet diameter of which is 60 in.

A similar disperser was fitted to the discharge valve of the Mukerti Dam in South India. Both the dispersers have now been in operation for a number of years and, so far as the writer knows, have given complete satisfaction.

F. F. FERGUSSON
Chief Engineer
Public Works Department
Jodhpur, Rajputana

Long Beach Harbor, Not Los Angeles

Sir: On the cover of the June 14, 1945, issue and also on page 102, you make reference to a retracting pontoon bridge as being in Los Angeles Harbor. I would call your attention to the fact that the bridge is entirely within Long Beach Harbor, which is an entity in itself. It has been developed entirely with Long Beach money, it is financed on a sounder basis than many harbors in this country because it has been supported by rich oil resources and it has already become one of the leading ports of entry and shipment on the West Coast. There is considerable evidence that it will at least equal and may exceed the facilities available in the Los Angeles Harbor.

A. A. KNOLL
Business Manager
Long Beach Board of Education
Long Beach, Calif.

Jet disperser for dissipation of energy from a 60-in. discharge regulator of 77-ft. head on the Shongwien Dam at Durban, South Africa.

EDITORIALS

VOLUME 135 NUMBER 8

August 23, 1945

FRUITS OF VICTORY

Civil engineers and construction men, never less and often more than those of other occupations, can look back with satisfaction upon their contributions to the victory that we celebrate. Theirs were responsibilities and tasks that antedated hostilities, accompanied attack, eventually encompassed the world and now are focused on consolidating the peace. In uniform or out, at home or abroad, at the battlefront or in support thereof, these men, readers of this journal many of them, made victory certain.

The reward for such loyal and valiant service must be found in the heart for the most part. And there it will be found, jubilation tempered with solemnity, happiness with sympathy for those bereaved, and glorious visions of a bright future with reverent regard for and thankfulness to those whose death or irreparable disability made all this possible. It was an "engineer's war", and the engineers did their part in winning it.

Now that peace has come, other responsibilities and tasks lie ahead, some anticipated, others still hidden, as it were, in the mushrooming dust and debris that the world's first release of atomic energy caused to soar above Hiroshima and Nagasaki. Out of the nuclear research so spectacularly introduced may indeed come a universal and permanent peace, a new and inexhaustible power source, and a whole galaxy of medical miracles. It stimulates impatience for quick achievement.

Yet, while acknowledging that the atomic bombs heralded a new era, not just merely the end of the war, the fact that atom-smashing dividends for peacetime pursuits will not be paid for a number of years needs to be faced. While waiting for the scientists and the power specialists, the rest of the world must live, in fact live fifty percent better than ever before if the planners are to be heeded. That is the challenge of this time of victory, and one worthy of the principles for which the war was fought.

For the construction industry the challenge is a particularly welcome one, since it means that once again engineers and construction men can assume their normal function of fixing capital in improvements for better living—houses, roads, water supply, sanitation, power plants, flood control structures and factories—and turn from their unwanted roles as facility-builders for war. Moreover, the demand for their services and products is tremendous and compelling. Theirs is the opportunity to provide jobs, thousands of them; and theirs is the responsibility to satisfy needs, long postponed and numerous. Better fruits of victory can hardly be imagined.

There are, of course, problems to be overcome. Manpower is temporarily short, materials bottlenecks will develop, there will be too much of one kind of equipment, not enough of another, and transport for both equipment and materials may be difficult. There are also several broad questions to which answers, though desirable, will only appear as time goes on and experience unfolds: How hard should public construction be pushed until the needs of private construction are known? Do we have enough plans ready to tax the capacity of the construction forces of the country? Are construction costs and wages going to be in such a relation one to the other that the workmen who build the houses can afford to live in them? And then, finally, there are the problems incident to assembling engineering and field staffs, and welding them into efficient organizations. The future will have its troubles.

As in the past, however, troubles will disappear, and the problems will prove solvable. Some aids to their solution are, in fact, visible already, notably in the incisive report to the President by Reconversion Director John W. Snyder, and in the rapid way in which private industry is going about reconversion and the building or remodeling of plant facilities. Even the emergence of the expert soothsayers with their emphasis on unemployment instead of on jobs is more troublesome than serious, the desire to produce and the demand for things being so great that their figure of 8,000,000 unemployed by next spring will prove to be utterly fantastic; unless we talk ourselves into it, which is perhaps possible.

All in all, in contemplating the future, the credits exceed the debits, and the end of hostilities finds the construction industry optimistic and well prepared. While reveling in the past, as it has won the right to do, it also will not fail to use the lessons of this past in accomplishing the job of the future—making this a better world in which to live. When this has been achieved, the fruits of victory will be truly ours.

Rush Jobs for Congress

When Congress convenes on Sept. 5, a number of important engineering bills will be waiting consideration, as pointed out elsewhere in this issue. The Missouri Valley Authority question will need to be answered, a decision reached as to the amount of federal aid to be provided for airport construction, and the federal government's postwar role in housing evaluated. Then in acting upon the "full employment" bill, the role of construction will need to be carefully weighed, while in the meantime appropriation bills relating to roads, hospitals, sanitation, and the work of the Bureau of Reclamation, the Army Engineers and other agencies will require attention. It would be a sizable task for Congress even if its attentions could be focused exclusively on the problems of construction. That being impossible, first attention should be given to those matters requiring policy declarations. Only when such policies are known can the construction industry proceed with certainty and full vigor to do its part of the reconversion task.

Promise and Performance

How much construction how soon is a question that is uppermost in the minds of many people today. From an analysis presented in this journal several weeks ago (June 14, vol. p. 841) it was concluded that the best accomplishment within one year—based on removal of all restrictions on manpower, materials and equipment—could be measured by a volume output of $5.3 billion. We still believe this to be a valid and realistic appraisal of the construction industry's performance potential in the next twelve months; and the projection of our analysis indicates that two years hence the volume output may be expected to be at the rate of $8.6 billion annually. It is well to keep these figures in mind because the optimism created by Japan's surrender tends to create inflation in performance promises. Only last week, for example, the director of the American Society of Civil Engineers' committee on postwar construction was reported in an *Associated Press* dispatch from California as having predicted a $15 billion program for the first year after V-J Day; either he was misquoted or is unduly optimistic, because this figure represents almost 500 percent greater rate of output than at present, while at no period in the past has the construction industry been able to show a rate of expansion greater than 62 percent annually. Confidence in the construction industry and the part it can play in maintaining high employment will be harmed if promised goals are not in accord with possible performance.

Atomic Achievement

With the spotlight quite naturally focused on the chemists and the physicists for their great atomic bomb achievement, and with everyone's thoughts turning to the theory, the processes and the possibilities of atom smashing, next week's issue will contain an authoritative presentation of facts directed to that end. In the meantime it is proper to recall the vital part played by the construction industry in providing the facilities from which the achievement emerged. Indeed, so basic and enveloping was the part of construction that responsibility for the job was centered in the Corps of Engineers, while the great bulk of the expenditures, which make up the tremendous investment, was made by and for the civil engineers and construction contractors who, with the help of subcontractors experienced in installation of process materials, built the great plants required with record-breaking speed.

It is difficult to sense the size of the project, although some idea may be gained from the fact had the construction contract amounts been added to *Engineering News-Record's* statistics, instead of being filed for safe keeping until the secret was announced, 1943 construction volume would have been increased 20 percent. Another measure of the immensity of the construction work is contained in the statement that each of the principal contractors had a construction payroll aggregating a million dollars a week.

When the work of the Clinton Engineer Works in Tennessee, the Hanford Engineer Works in the state of Washington and the special facilities in New Mexico are added together, they become the largest and most spectacular coordinated construction project in history. And when the details are presented in a series of articles now being planned for this journal, the project will also be seen to rate an accolade for the speed and originality with which it was built.

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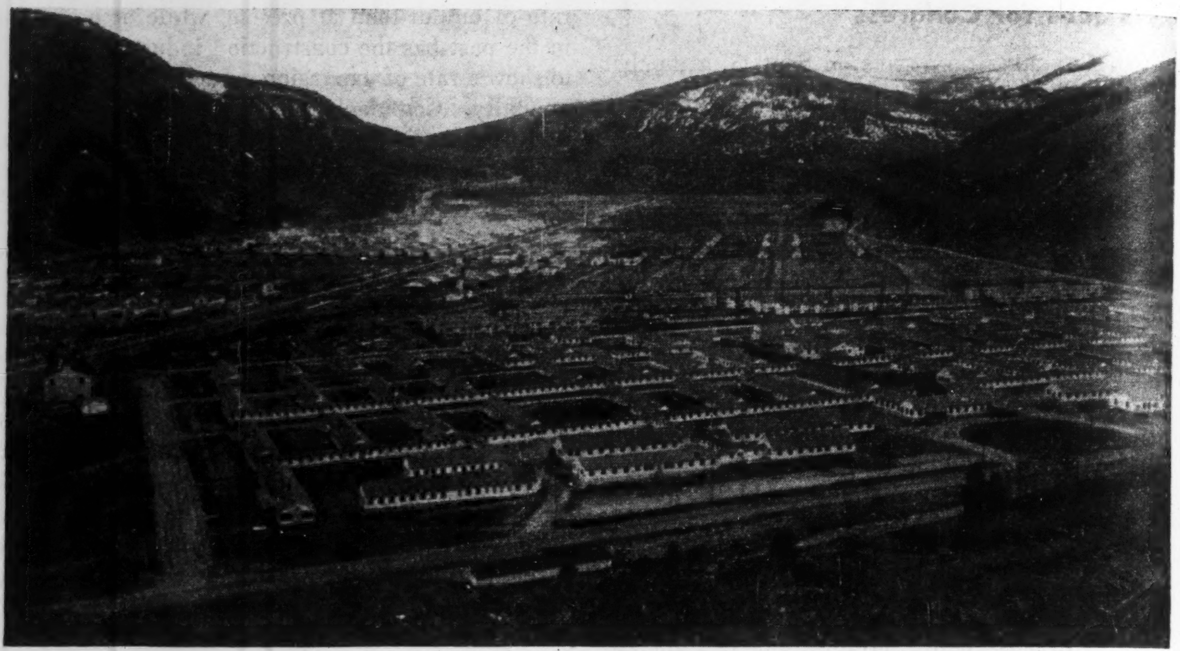

Fig. 1. Camp Hale in the Colorado Rockies is the first camp to be demolished by the Army Engineers.

Salvaging a Big Army Camp

Editor's Note*—Construction in reverse, dismantling instead of erecting, releasing critical materials instead of procuring them, saving the taxpayers' money instead of spending it—all these are welcome shifts in the business of building for war as portrayed by the demolition of Camp Hale, Colo. Through well-planned and well-executed operations, the big camp is being efficiently and economically dismantled and entirely salvaged by the Army Engineers with prisoner-of-war labor, thereby furnishing critical materials to other military installations. While the engineers on their first camp demolition project have set a fine pattern to follow, Camp Hale efficiency and results can be continued only while prisoner-of-war labor is available and as long as there is a demand for the salvaged products.*

TRADITIONAL packing house saving of "all the hog but the squeal" has nothing on the U. S. Army Engineer salvage operations at Camp Hale, Colo. Here a $32,000,000 camp, specially built for training mountain ski troops, is being completely dismantled by German prisoner-of-war labor with use being found for everything down to the last nail, shingle, brick and scrap of lumber. Some of the 1,070 buildings are taken down in sections for re-erection at other Army posts, the rest are torn apart and all materials and equipment are saved, sorted and then reclaimed.

Camp Hale is located in the broad Eagle River Valley just west of Tennessee Pass, Colo., at an elevation of 9,500 ft. Designed for heavy snow loads and extreme weather conditions, it is one of the best-built cantonments in the country. Barracks and other occupied buildings are all insulated with fiber board covered with cement-asbestos shingle siding and slate-type asphalt shingle roofing. The larger shops and warehouses are of bolted truss roof construction, with 95-lb. slated felt roofing.

Three ski tows, part of the training equipment, have been turned over to the U. S. Forest Service for subsequent civilian use. They are the only part of the whole camp installation to remain. Fortunes of war declared the camp surplus in 1944 after the 10th Mountain Division, which saw service in Italy, had completed its training. The clean, well-built camp in a beautiful Rocky Mountain setting would have been ideal to retain as a hospital and convalescent station except for one thing, the high altitude.

A job without precedent

The project is under the general direction of Brig. Gen. R. C. Crawford, division engineer, Missouri River Division, and Col. James V. Johnston, district engineer at Denver. Working out the unprecedented details was left to five men: Lt.-Col. C. S. Stahl, construction engineer for the division; Maj. Don A. McKinnon, construction engineer and George S. Porter, chief of operations, Denver district; Capt. Leon D. Howard, resident engineer at the job and Coleman

Mulligan, civilian general superintendent from Townsend, Mont. These men had no experience to draw on, for Camp Hale is the first large cantonment to be wrecked in this war. Furthermore, the project involves much more than merely demolishing the facilities, it is primarily a salvage job to make available critical materials and supplies desperately needed elsewhere in expansion of hospitals and certain war plants.

First a general plan of attack had to be worked out for efficient and smooth operation. Otherwise, the job would be buried in debris. Labor and supervisory personnel must be housed and fed in buildings that are to be torn down. These housing areas must be kept supplied with water and power, while utilities are being demolished on all sides. Fire protection must be intensified because of large stacks of lumber and other combustible material. Wrecking procedure must follow a well-planned pattern that will keep the workmen spread out, keep traffic lanes open, make possible a smooth flow of materials into saw mills and rehabilitation shops and provide temporary storage for certain materials until shipped out.

Procedure for disposal of the salvaged items had to be established which is being handled entirely by the Denver district and Omaha division offices. At the job railroad and trucking facilities for moving out materials and equipment must be arranged for daily. And, of course, records must be kept of everything.

Buildings and red tape lumped

However, because of the speed at which the project is being carried out (and vice-versa) much of the usual army red tape and office work happily has been dispensed with. No attempt is made to keep track of material and supplies that come out of individual structures, they are all lumped together and charged out to the various projects to which they are sent. An idea of the size of the dispersing job can be gained from the fact that from the start last Feb. 22 up to June 28, with 79 percent of the job complete, 879 carloads and 350 truckloads of salvaged material had been shipped out. Included are 14,800,000 f. b. m. of lumber.

The job organization under Captain Howard includes a few military aides and 350 civilian employees made up of area superintendents, foremen, timekeepers and office personnel, carpenters, electricians, plumbers and equipment operators. To start the work 500 German prisoners were brought in on Feb. 22 as the labor gang. Later this force reached a peak of 2,800 but never more than 2,300 were ever available for actual job duty. The first step was to make a prison compound out of a group of barracks. Post holes for the barb wire fence were drilled in frozen ground with jackhammers, and the posts were set in water which immediately froze as a solid anchor. Later, as the ice thawed, it was replaced with tamped soil.

While the wrecking and salvaging

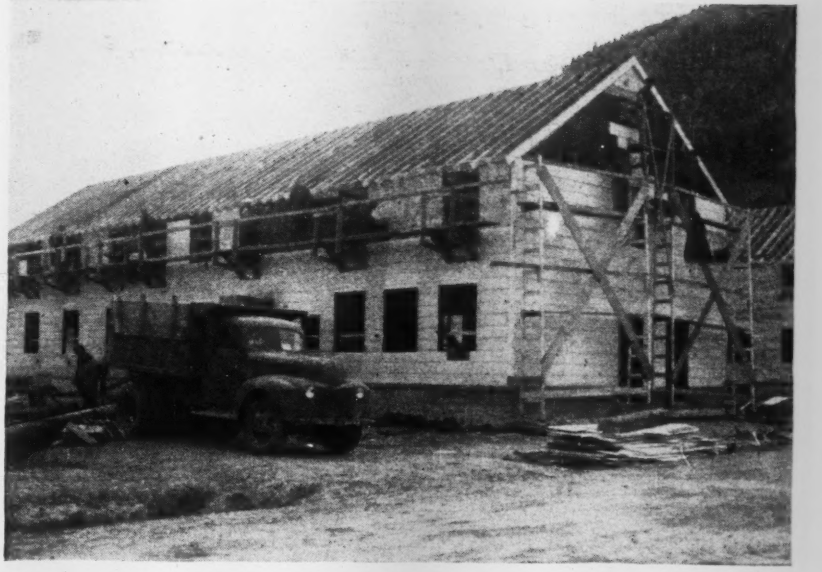

Fig. 2. German prisoners work from window jack scaffolds in removing siding from the buildings. More than 2,000 prisoners were used.

Fig. 3. Prisoner blacksmiths developed a thin-jaw clawbar for pulling nails out of cement-asbestos shingles without damage to the shingle.

Fig. 4. Some buildings, where it is advantageous to do so, are sawed apart and match-marked for re-erection at other military establishments.

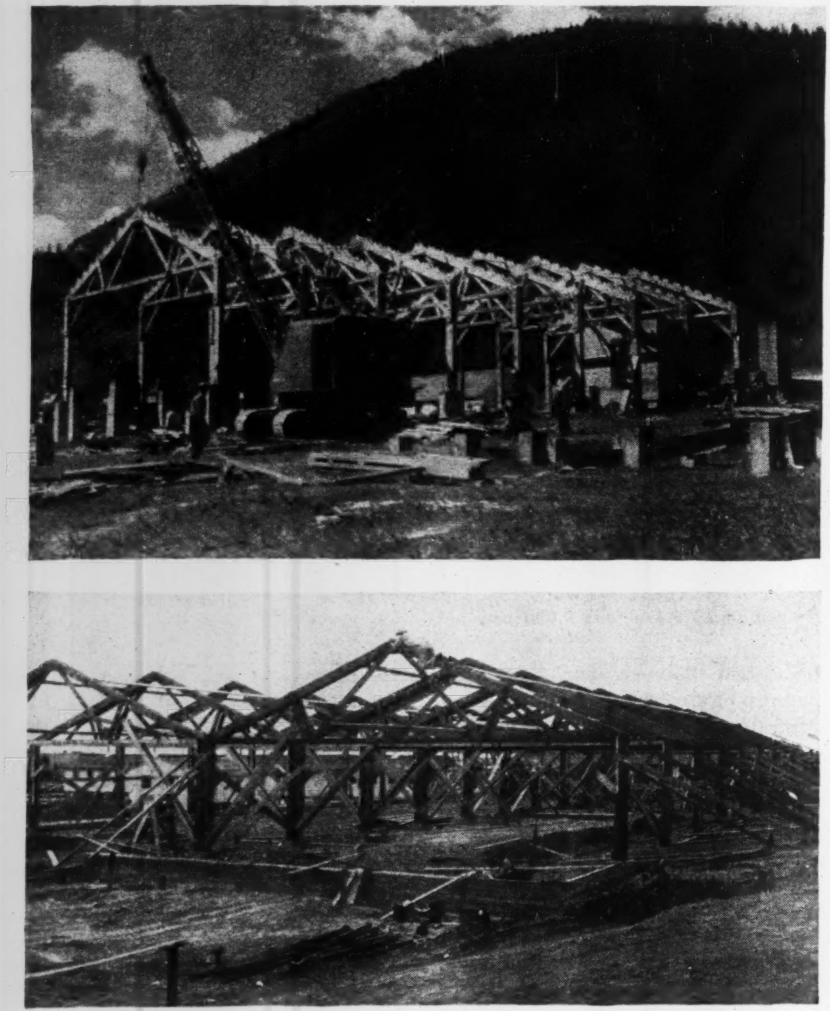

Fig. 5. Bolted trusses are lifted off their columns intact at Camp Hale (top). Trusses are used again for a structure at Fort Logan (below).

are primarily hand operations, considerable equipment is also used. This includes scores of trucks, shovels, cranes, bulldozers, compressors and air tools, saw rigs, and shears for trimming asphalt roofing and shingles. Prisoners are used as truck drivers, but all other heavy equipment is operated by civil service employees.

Hand tools were a problem, for more than 2,000 clawbars and hammers had to be obtained in a hurry. Prisoner blacksmiths relieved the tool shortage by making clawbars and crowbars out of iron stock found at the camp. Then they went on to develop special tools, such as a thin clawbar for removing cement-asbestos shingles without breaking them, Fig. 3, and the roofing shears.

While the general plans had been made in advance, actual wrecking procedure was developed by the cut-and-try method. Area superintendents were allowed to try out any method they deemed feasible, and if it worked without undue damage to the materials it was adopted. Buildings were attacked in separate groups so as not to clutter up the haul roads. At first snow was a big nuisance, the roads had to be cleared constantly, working space around each building had to be cleared, and roofs had to be swept clean to remove daily snowfalls that amounted to as much as 14 in.

It was soon found best to divide the labor force into functional gangs, each of which followed through from building to building performing the same task on each. First crews strip out all the electrical work. Followed by the plumbing gang. Concrete floors in the lavoratories are broken up with pneumatic concrete busters. Then the windows and doors are removed intact with frames, glass, screens and hardware, later crated for shipment.

Dismantling the buildings is done by one of two methods: Some are cut up into panels and match-marked for erection elsewhere; others are torn down piece-by-piece. In the latter case the roof shingles are stripped off first and slid to the ground in chutes. Then the underlying roofing felt is removed and rolled up. Roof sheeting and rafters are taken off next. Meanwhile, a crew starts pulling off the cement-asbestos wall shingles with the special claw tool, which can be driven under the nail head without breaking the shingle. The crew works from scaffolds hung from window jacks. These wall shingles must be passed to the ground by hand to prevent their breaking.

Floors are salvaged

Wall and floor framing is removed after the floors have been taken up. Some buildings have hardwood flooring that is salvaged completely, the nails being pulled through the wood by special-grip clawbars after the flooring is pried loose. Asphalt tile flooring is steamed loose, pried up and cleaned at once in a hot solution.

Roofs of the warehouses and other large buildings contain 37-ft. bolted timber trusses, which are lifted off intact by cranes for shipment as units. Columns are dismantled. These larger structures often have 95-lb. slate-asbestos roll roofing instead of shingles, which cannot be re-rolled, but can be salvaged by handling in flat sheets later cut up into shingle size.

Boilers, unit heaters, kitchen equipment, fans, motors, roof smoke jackets, and such equipment are removed early in the schedule. Brick wall stacks are pulled over, then broken up and all brick is cleaned and salvaged, as is also all brick in the warehouse fire walls. Cinder block foundation walls in the hospital area are likewise salvaged.

Fire hydrants and risers are uncovered and then pulled out by backhoes. Soil pipe is removed and saved intact with connections. Deep well pump units, transformers and other heavy outdoor equipment are salv-

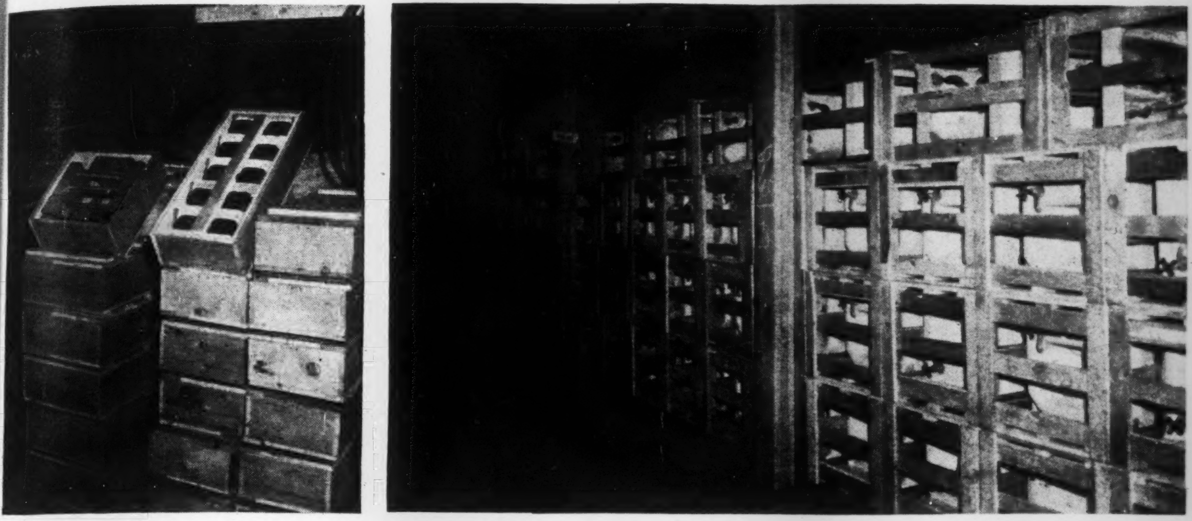

Fig. 6. Scrap lumber is used for boxes and crates for shipping salvaged items such as electric fixtures and sinks. Note the neat job of packing and orderly arrangement of material to facilitate shipping.

aged, rehabilitated and shipped out as complete items. More than 2,800 electric motors have already been saved. Insulation around steam lines in the hospital corridor is removed and rolled up prior to dismantling the lines.

The sites are leveled off with a bulldozer, and all broken brick and other debris not worth picking up is covered up, leaving only the concrete floors and foundation walls exposed. Studies are now being made as to the possibility of breaking up this concrete for use as riprap on nearby projects. The dismantled camp area is being left clean. Each local area is cleaned up as work progresses.

Salvage operations

Wrecking has been reduced to a fast and efficient operation, but it is the salvage of the wrecked materials that is the payoff on this job. Again, there was no precedent to follow, but Camp Hale has set a pattern that might well be followed on any similar project.

All nails are pulled from the lumber at the building site. As far as possible, nails are swept up and saved, not for use but for salvage as scrap and to minimize accidents and tire punctures. Of course, many nails get scattered over the haul roads, and after the grief of 86 punctures in one day, Captain Howard mounted three magnets, charged by a portable light plant on a truck, which patrols the roads with good effect in picking up nails.

Lumber is cleaned and then squared and split ends removed in saw lines, retaining the maximum standard length possible. After rehabilitation it can be classed as its original No. 1 grade. Saw lines are set up at strategic points where reclaimed lumber can be stored for easy loading.

Of course a vast amount of short scrap lumber accumulates, but it is being used to good advantage. Part of it goes into boxes and crates for shipping the salvaged items, but much of it is now being made up on order into pallets and boxes for the ordnance department. Up to July 1 orders had been placed for 270,500 boxes and pallets that would cost, according to ordnance contract prices, $559,250. Most of these orders have already been filled at negligible cost.

All unusable scrap lumber is piled up for sale to nearby towns as kindling. Bids have been taken on 2,400 tons of kindling, which indicates the size of the job, for the percentage of unusable scrap is very low.

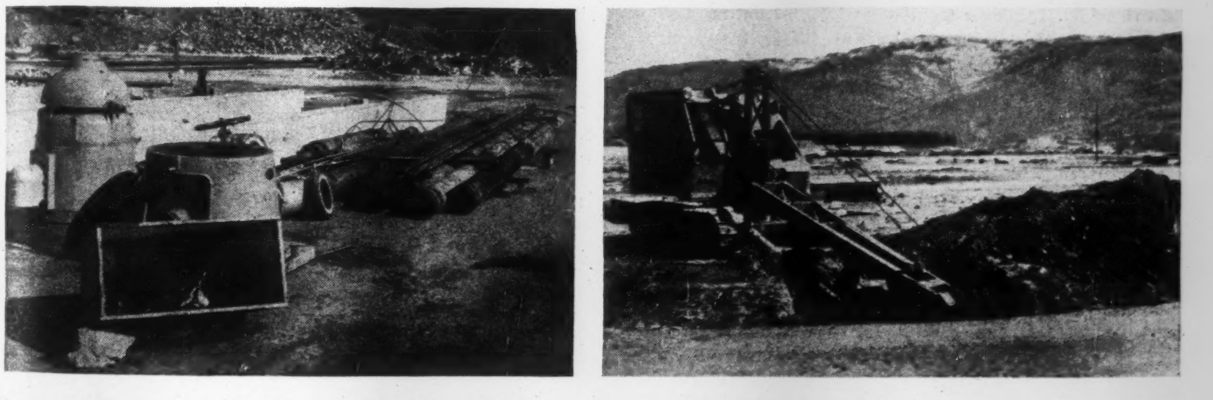

Fig. 7. Utilities are salvaged for use elsewhere. At left is a deep well pump outfit complete with pump, casing, rods and fittings. A backhoe at the right pulls a fire hydrant and riser loose from the main.

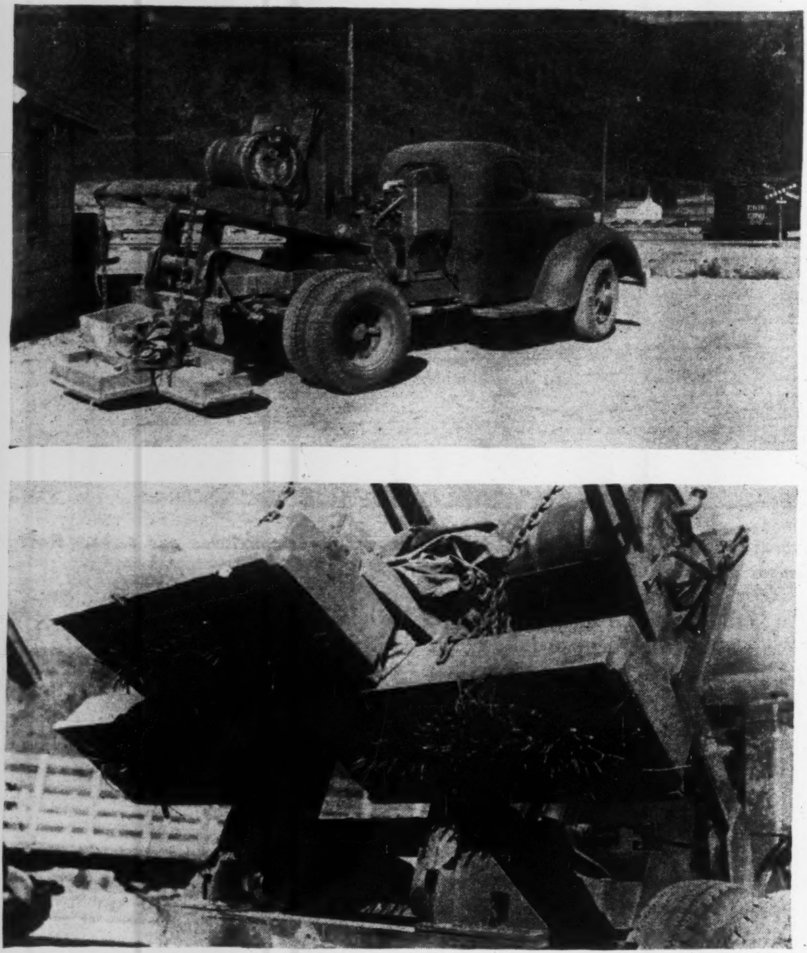

Fig. 8. All too many tire punctures led to rigging up a truck-mounted magnet for picking nails and tramp iron from the haul roads.

All electric wiring and fixtures are taken to a central shop. The fixtures are inspected, cleaned, repaired if necessary and possible, and stored in bins for packing. Wire is rolled up in convenient lengths and tagged as to type, size and length. Even pieces as short as 10 ft. are so treated, to be used for short runs on some other job. Light bulbs are tested before being stored.

Plumbing fixtures and small piping are similarly handled. Piping is completely dismantled, all connections and fittings are removed and stored in classified bins. Large fixtures, such as toilet bowls and sinks, are boxed for shipment.

Unless an item is in good shape for re-use, or can be rehabilitated on the spot, it is scrapped. Everything shipped out to other jobs is in good workable condition, properly tagged and marked as if it were a new shipment coming from a manufacturer.

The supervisors have done an excellent job in designing shipping boxes and crates for the salvaged material. Protective packing for the more fragile items is available from the thousands of squares of insulation. Use has also been found somewhere for this material, hard to salvage in very large pieces, as insulation for refrigeration rooms and units.

Shingle made from salvage

Shingles are made from the heavy slate felt roofing by cutting the large sheets up into standard-size multiple shingles. Even the slots are cut that give the appearance of individual shingles when laid. The original-cement-asbestos wall shingles have scalloped bottom edges. Frequently the corners are broken, and when the sides are trimmed square the scalloped curves do not match. However, recommendations from Camp Hale that these reclaimed shingles be laid with the scalloped ends up, exposing a square bottom edge, make them usable elsewhere.

Camp Hale has also become a manufacturing center. Besides the pallets and boxes made for ordnance, other wood items are being made up on order. An illustration is an order for 6,300 timber columns of 6x6 in. dimension, and from 16 to 20 ft. long, which was filled by laminating 2x6's into the required length. Even the 3x6-in. wood staves from the water tanks are being fabricated into columns.

Cost keeping

Shipments of material from Camp Hale, up to June 28, are valued at $3,036,000. Detail costs and man-hour requirements are being kept on every operation for future reference. Efficiency of the job is strikingly illustrated by a total overall cost to the government of only $410,230 for the period up to June 28. Prisoners are paid the prescribed rate of 80c. per day but their maintenance is not charged into the figure above as the Army has to take care of them anyway. The prisoners in general work well and steadily; malcontents and misfits are quickly weeded out and returned to the main prison base at Greeley, Colo.

However, the low cost of the work is due in large measure to the excellent planning and supervision of the work. For possible future use in estimating similar contract operations comparable costs are kept based on a labor rate of 80c. per hr., which prevails in the Camp Hale district. A third set of figures is made, based on the union scale of building trades in Denver.

According to present schedule, the entire job will be completed early this fall, providing the size of the labor crews are maintained. Some 700 prisoners have been transferred to a similar job in Alaska, and replacements are slow to come in. Then, too, there are interruptions, such as taking time off to fight forest fires. While the supervisory force do not like to see the work slowed up by these interruptions, Major McKinnon points out they can save more lumber by fighting forest fires than they can tearing it out of camp buildings for salvage purposes.

Drainage Canals Aid Mosquito Control In TVA Reservoir Areas

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***Contents in Brief**—Swamps along the edges of TVA lakes, as well as depressions within the fluctuation zones of the impounded waters, are connected with deeper parts of the reservoirs by drainage canals. Breeding locations of the malaria mosquito are thus eliminated. Methods used in digging these canals are described and unit costs are given.*

IN HARNESSING THE STREAMS of the Tennessee Valley for navigation, flood control and power, the great dams of the Tennessee Valley Authority created many bodies of impounded water. These lakes along the Tennessee River, flooding the edges of swamps where malaria already was prevalent, constitute natural breeding places for *Anopheles quadrimaculatus*, the mosquito that carries the malaria germ.

Every precaution, therefore, had to be taken to render these potential breeding grounds unsuitable for reproduction. Drainage of swamps and depressions played an important part in this work when coordinated with other mosquito control measures.

Before the lakes were filled a careful job was done of clearing away the forests, with special refinements for the marginal areas (see *ENR* July 12, vol. p. 38). Then all of the area to be inundated was carefully policed and everything that might create flotage was burned or removed. Just prior to impoundage, as a final measure in clearing away anything that could lend encouragement to the mosquito, all sprouts and annual growth that had grown subsequent to clearing were closely cut in the portions of the lakes where the water would be shallow at full pool, and from which it would recede entirely during the dry weather season.

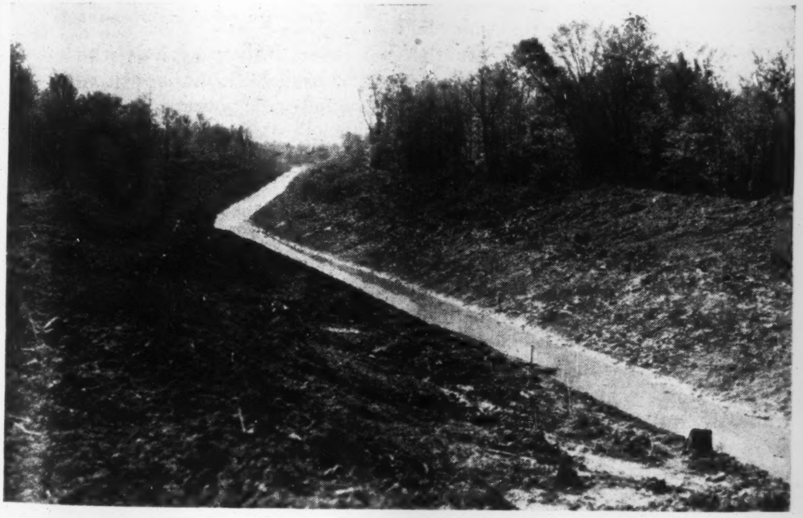

Fig. 1. Depressions and swamps in the fluctuation zone of TVA lakes are connected with deeper parts of the reservoirs by drainage canals that also provide boat channels for larvicidal crews. Swamp ooze when dried like this becomes hard and will resist the erosive effect of heavy rains. Note the uniform slopes.

After the reservoirs were filled and the dams were in operation, some mosquitoes, more persistent than others and determined to carry on their cycle of reproduction, deposited their larvae in the quiet water near the margins of the lakes. As a counter measure, the lakes are fluctuated. Throughout the mosquito breeding season they are periodically lowered a fraction of a foot, permitted to stand for a few days, raised a bit, then lowered again—this time to a lower elevation than they were the first time they were brought down—and so on throughout the summer. Every time the water is lowered the mosquito larvae are stranded along the edges of the lakes. Here, deprived of their natural habitat, they dry up and die.

When in this process of fluctuation the water is brought to a lower stage, it leaves an increasing expanse of land. By the end of the summer this strand has grown in width from a few yards, where the banks are steep, to a mile or more across the big flats.

Depressions require drainage

In some of this land there were numerous depressions, varying in size from a few yards in diameter to a potential lake several hundred acres in extent, that had no natural outlet for the water. Unless something were done about this condition these stagnant pools, left behind as the waters of the lakes recede, would become the comfortable homes of billions of mosquito larvae. The logical correction was to connect these depressions with the deeper portions

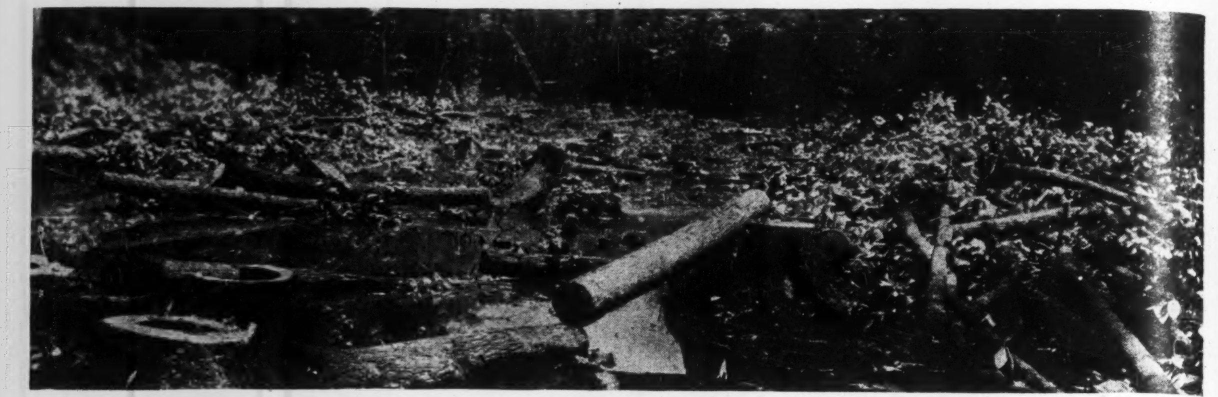

Fig. 2. Right-of-way crews cleared ahead of ditching operations in swamps bordering the reservoir. Equipment used was a ½-yd. dragline with 35-ft. boom operating from mats made of small logs lashed together with cables.

of the lakes by drainage ditches.

Some of the depressions, especially lime sinks, were deep—too deep to be drained completely. Also, although ~~some~~ of the lime sinks lie outside the lake area they are connected to it through a porous substratum and fill with water as the lake fills. As the lake is drawn down, however, the water in these lime sinks recedes too slowly to prevent breeding of mosquitoes. A ditch was built connecting each with a deeper part of the lake. This ditch provided fluctuation for the water in the depression so that it rises and falls with the waters of the lake, stranding the mosquito larvae. These canals also serve as boat channels when larvicidal work is necessary.

Marginal swamps also drained

In some of the great swamp areas along the Tennessee River, conditions on adjoining land controlled by the TVA were so favorable for mosquito production that drainage canals were extended beyond the lake area. Here, too, sluggish swamp creeks choked by logs and other debris were cleaned out beyond their junction with the lake and made to run freely.

Another problem was posed by flood control storage similar to that encountered at Kentucky Dam. Here great swamps that were not cleared will be flooded when the waters of the lake are raised some 15 ft. above the normal pool level.

If the waters in these swamps would have followed completely the recession of the lake as the flood season waned, all would have been well. But unless provision had been made to take care of these flood waters they would have remained behind in sloughs and depressions that had no outlet, and would soon have been alive with mosquito larvae.

Through the worst of these marginal areas beyond the lake, a main canal was dug from the reservoir to afford drainage to the larger bodies of water back in the swamp. From this trunk canal laterals were constructed to tap the numerous other depressions. When the lake is drawn down after floods, this complete system of drainage provides that nothing will obstruct the flow of the water from the swamp.

After each new dam was approved and the confines of the reservoir established, the resident sanitary engineer made a careful study of the area to determine the nature and extent of the drainage that would be necessary in that reservoir for the control of malaria.

This planning by the resident sanitary engineer was related to long-range economic considerations. In making his studies, he was faced with the problem of deciding whether an area should be drained, or whether mosquito breeding could be more economically controlled by larvicidal methods—a conclusion sometimes hard to reach. Larvicidal control might mean an expenditure year after year over a long period of time, while a drainage ditch through the area, drawing off the water and providing fluctuation, might bring about adequate control with no further cost.

Along with clearing and its other work of preparing the reservoirs for flooding, the reservoir clearance division constructed the drainage canals in the marginal areas for malaria control. The division's field superintendent and the resident sanitary engineer worked closely together, not only on drainage but on all preparation for future malaria control. One was the scientist, planning and working to inhibit the breeding of mosquitoes; the other was the operator, with a pride in the economy as well as in the efficiency of his job.

In spite of this difference in the angles of approach, and in spite of many earnest discussions in bringing together opposing ideas on methods and costs, they always managed to meet on the common ground of the ultimate objective. The result was a system of drainage both economical in construction and efficient in performance.

Canals used as boat channels

Those drainage canals which were to be used as boat channels were constructed with bottoms from 4 to 6 ft. wide. Posts were set along the banks of the canals to serve as navigation markers for small craft doing larvicidal and other work after the lakes were filled. Experience had proved that posts sunk in the ground with no anchorage would not remain in place during submergence. To secure them, a circle was notched around the bottom part of each post, the post was set in the hole, and a mixture of 3 parts of sand to 1 part of cement was poured into a depth of about 8 in. and wet down. This concrete collar kept the post immovably in place.

Small draglines equipped with ½-cu. yd. buckets and 35-ft. booms were used on the major drainage. Although larger equipment might have proven more efficient under certain conditions, these light machines were much better for over-all use. For most of their work in the swamps they traveled on and operated from mats constructed of small logs lashed together with cable. But occasionally the end of a mat went down and the machine slid off. Then, with very little but the boom remaining above the mud, and with the limited facilities at hand to get it out of trouble, it was a matter for congratulation that the machine was not any heavier.

Then, too, for short distances, these little machines moved quite readily under their own power from one project to another, dragging behind them a log wagon on which the mats were loaded. The strength of bridges to be crossed was no great problem, as even a well-constructed farm bridge gave no trouble. For long moves, of course, a barge on the river or a heavy trailer was used.

Through the firmer types of soil, ditches were constructed with 1 on $1\frac{1}{2}$ side slopes. Occasionally one was built with 1 on 1 slopes, but where caving or sluffing might be expected slopes of 1 on 2 were used. In swamps, in order to make allowance for the ooze that often flowed back into the ditch, excavation was made a few inches below grade. On deep cuts of any length, one of the small draglines was placed on each side of the ditch and the two of them worked as a team.

In the upper end of the valley considerable rock was encountered. Some of this was shale or boulder formation that could be scratched up and lifted out with the dragline; but drilling and shooting often had to be resorted to before the rock could be removed. This latter was, of course, more expensive.

Dragline operators trained on job

Another problem that arose was that considerable difficulty was experienced in getting or retaining competent dragline operators. Some who qualified were accustomed to working under altogether different conditions and soon left; others were just unable to construct, under swamp conditions, a proper ditch with uniform slopes. Therefore, operators were trained on the spot.

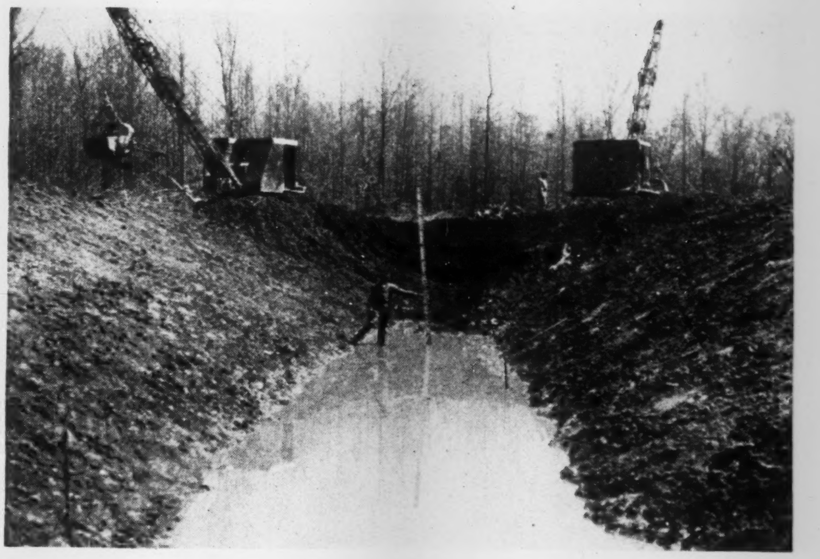

Fig. 3. On deep cuts two ½-yd. draglines worked together as a team, one on each side of the ditch, to dig canals with 1 on 1½ side slopes and bottom widths of 4 to 6 ft.

The crew of each dragline was comprised of an operator and an oiler. With an eye to the future, the oiler was carefully selected and placed in training under the operator. If, after a reasonable time, he did not show promise of further development, he was replaced with another man. In addition to oiling and helping with the mats, he was out in the ditch much of the time checking slopes and depth for the operator. For an hour or two each day, under close supervision of the operator, he took a turn at running the dragline. The result was that those who made good as oilers eventually became some of the best operators.

Preceding the dragline, the right-of-way crew often worked waist-deep in mud and water to fell the timber and move it out of the way. Immediately following this crew came the dynamite man and his helper, blasting obstructing stumps. This required considerable skill; for, instead of blowing the stumps out of the ground, with the resultant crater, they were thoroughly shattered so they could be readily lifted out in the dragline bucket.

When drainage was below the normal pool elevation, right-of-way work—except the removal of stumps—was absorbed in the general clearing account. But when the ditches ran into the swamps beyond the clearing line, clearing rights-of-way was a substantial part of the cost of drainage.

Some of the small ditches, when they were widely scattered and would have required excessive movement of the draglines, were dug with teams and slip-scrapers. To facilitate loading and moving this equipment, a $1\frac{1}{2}$-ton truck was fitted up to carry a team of mules and a scraper. Perhaps within an hour after one ditch was completed, work would begin on another several miles distant. Where no boat channel was needed it was often economical to construct small ditches by hand. The unit cost of excavation was, of course, much greater when slip-scraper or hand method were used than when draglines were employed. A wise selection of method, however, resulted in considerable over-all savings.

Hand methods prove costly

Construction by hand work cost about $1.00 per cu. yd.; by slip-scraper, from 50 to 75c. For rock excavation the costs ran from $1.00 to $1.50 per cu. yd., while excavation by dragline cost from 9 to 15c. Clearing and grubbing rights-of-way through woodlands and swamps always added another 7 to 10c. per cu. yd. For several million cubic yards of drainage for malaria control, in and above the marginal areas of the TVA reservoirs, the average cost was 21c. per cu. yd., which included right-of-way clearing, materials, explosives, and all other charges pertaining to drainage.

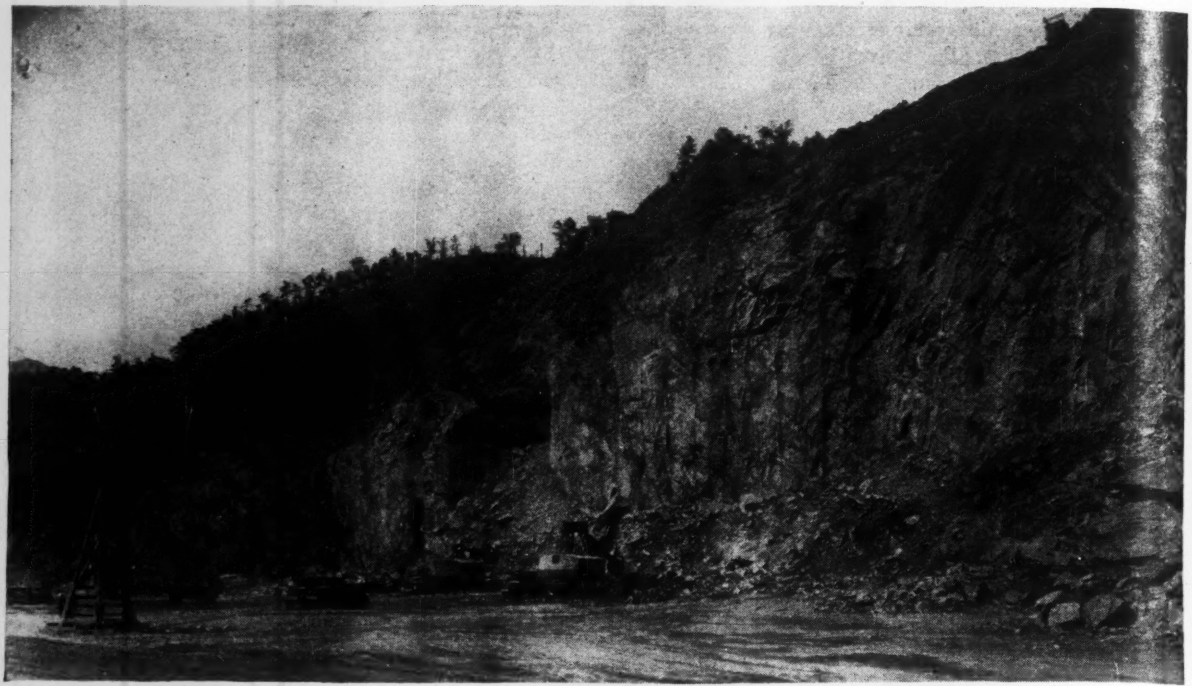

Fig. 1. Blast holes 325 ft. deep were drilled before a second face was developed at the 250-ft. level of the quarry.

Aggregate Production at Fontana Dam

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Contents in Brief—*Quartzite rock was quarried near Fontana Dam and processed into fine and coarse aggregate. The quarry was worked at two levels with faces totaling 400 ft. high, using 9-in. dia. holes for primary blasting. Secondary breakage was largely by "dobying". From 42-in. primary crushers, belt conveyors carried material through process and to storage and then to the mixer plant. Rod mills produced fine aggregate with a consumption of 0.8 lb. of steel per ton of sand. Duplicate crushing and screening equipment was installed to avoid delay from breakdowns.*

In a race against time, more than six million tons of quartzite rock was quarried and processed at the site to provide concrete aggregate for the Tennessee Valley Authority's huge Fontana Dam, constructed on the Little Tennessee River in western North Carolina as part of the essential war emergency program. The dam, highest east of the Rockies and fourth highest in America rises 480 ft. above the foundations and has required manufacture of nearly three million cubic yards of concrete. (*ENR* Nov. 16, 1944, vol. p. 633 and Nov. 30, vol. p. 689).

Concreting requirements, established by a rush schedule, made the problem of aggregate supply of prime concern. No commercial producers were available within any reasonable distance, railroad tariffs were high, and rail shipments of from 300 to 400 cars per day would require 1,800 to 2,400 cars, overcrowd existing railroad facilities and require greater storage facilities than could be readily provided. To assure uninterrupted concreting, fine and coarse aggregates were made locally by forces of the TVA.

The nature of quartzite, and the position of the Fontana deposit, which was restricted between two heavy slate beds only 900 ft. apart, together with the concreting demands for as much as 19,000 tons of stone in a day, made quarrying and processing of aggregate an unusual operation. With relatively little usable storage space available on the steep, actually mountainous, terrain the plant was "strung-out" crossing the river twice to take advantage of all usable areas. Careful planning and close coordination of production with requirements prevented delays to concreting operations, even when more than 425,000 tons of finished aggregate was required during the peak month.

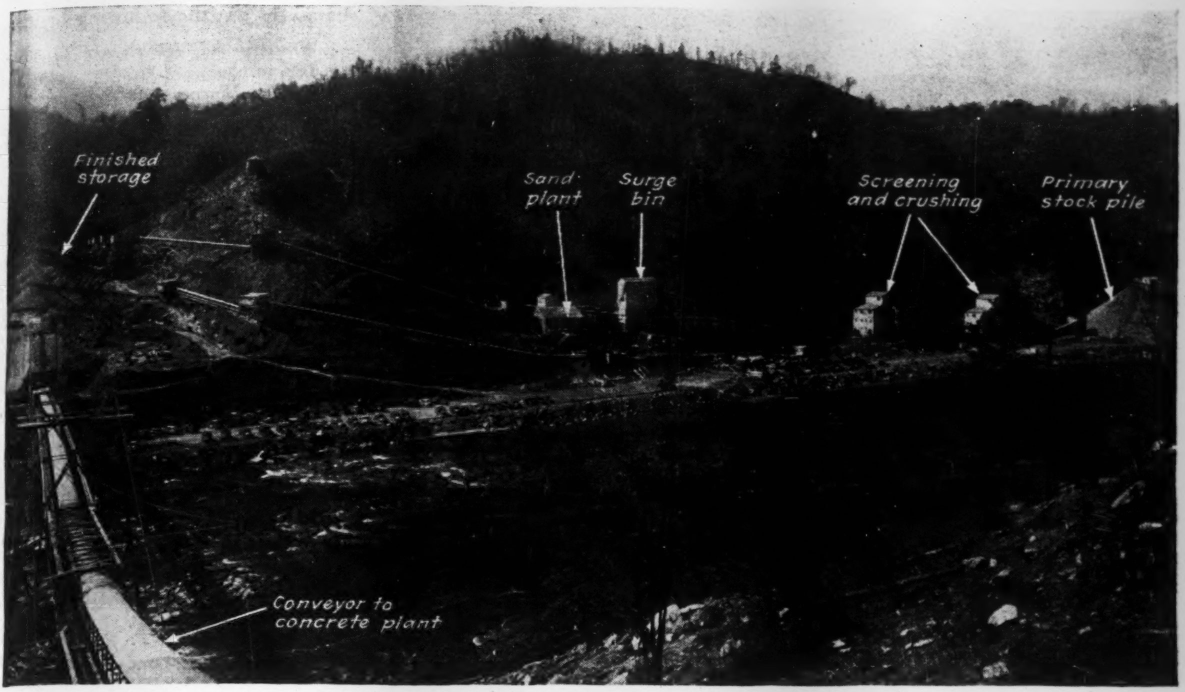


Fig. 2. Secondary crushing and screening plant as well as storage was on opposite side of river from quarry and mixer. Storage of material in surge bin permitted manufacture of sand when remaining plant was shut down.

The quarry site was on the right bank of the river about a mile downstream from the dam. The two slate beds, striking almost straight into the mountain and dipping upstream about 60 deg., bounded the working area and necessitated development of a face reaching the extreme height of more than 400 ft. The rock strata generally conformed to the bedding plane of the slate, with the exception of a disturbed area of fragmented material near the middle of the quarry which constituted a fold conforming to the position of a large "V" sloping toward the quarry face.

Natural fault divides quarry

Well drilling in the disturbed area was impractical and work below the area generally was hazardous. Most of this fractured rock fell out at the time of primary blasts, although it was not loaded and shot. Because of the restricted length of the working face the fault was utilized to divide the working area while quarrying. Primary blasts generally were made alternately on one side or the other of the fault, which permitted loading material in one end of the quarry while overhead work of scaling and the drilling for the next blast proceeded in the opposite half.

Soil and weathered rock covered the hillside of the quarry site and some 75 ft. of clay lay over its top. The overburden was removed by 2-cu.yd. diesel shovels and bulldozers working from the top of the quarry. The shovels excavated their way down the quarry face on shelves, which later became drill roads, casting the waste material down the hillside. All of the overburden was used in forming a berm for operation of equipment from which development of the face could start.

Two rows of wagon-drill holes were shot with 40-percent ammonia gelatin dynamite to begin quarrying operations. A row of well-drill holes, located some 40 ft. back of the shallow face established with wagon drills, were then drilled to a depth of 60 ft. Snake holes, horizontally in from the face, were then drilled at the toe with mounted drills in preparation for the initial primary blast.

Drilling of blast holes was accomplished with seven electric-powered, churn-type well drills using 9-in. dia. bits. Drill roads, established while stripping, were improved with a bulldozer and utilized successively as quarrying progressed, and the crawler-mounted drills were maneuvered over them under their own power.

Blast holes were drilled 15 ft. below the quarry floor to relieve the toe and a variety of drilling patterns were tried, to determine the subsequent spacing practice. Starting with 30-ft. spacing and 30-ft. burden and extending up to 45-ft. burden with spacing as close as 18 ft., it was found that the most satisfactory results were obtained in this deposit when the burden was about 35 ft. and the holes were spaced on 18- to 20-ft. centers. As quarrying progressed, some holes were drilled to a depth of 325 ft., but the position of the rock made it difficult to maintain proper alignment to this depth and resulted in excessive cable wear.

Deep drilling avoided

To eliminate the hazards of an extremely high quarry and difficulties of deep drilling, a second face was developed 250 ft. above the quarry floor. Access to this level was over a steep road, cut around one end of the quarry. This bench was started with wagon drills and developed to a width of about 80 ft. by use of well drills. When the bench was established, primary blasts were made along the upper and lower faces concurrently. The muck from the lower face provided somewhat of a cushion for material falling from the high elevation of the upper face.

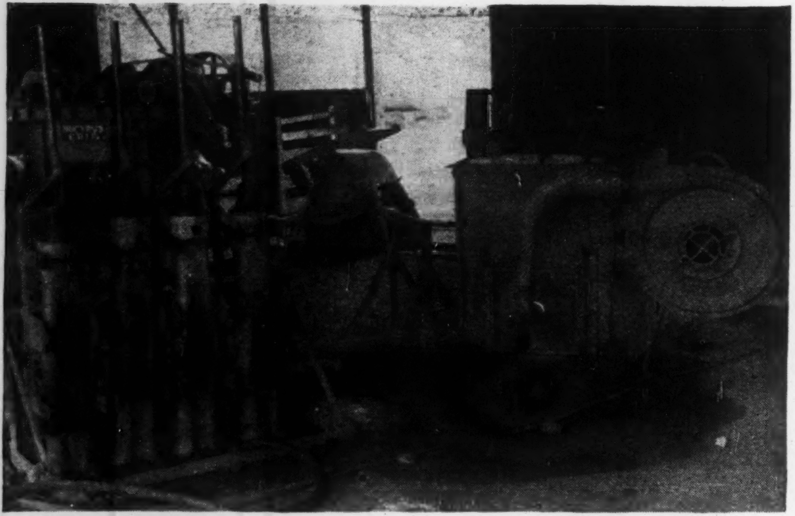


Fig. 3. Fifty 9-in. dia. drill bits were sharpened in 8 hrs. in job shop equipped with two bit-dressing machines, two forging furnaces and two tempering furnaces and quenching tanks with bit cradles.

Rock remaining on the upper bench was cast over the side with a 2-cu. yd. diesel shovel, aided by a bulldozer. This resulted in some stacking against the wall of the lower face, but the excessive height of the muck pile was minimized by working out ramps from each end of the quarry about 30 ft. above the floor. This permitted loading to proceed from two levels and the plan provided increased production in loading rock because the relatively narrow working area would not permit all shovels to work efficiently on the quarry floor. This also reduced the hazard of shovels loading from under a high bank of loose rock.

The final height of the face above the bench was slightly in excess of 150 ft. Further development of the upper face was discontinued when it became apparent that sufficient rock was available from the remaining portion of the lower face to fulfill all requirements. The last primary blast utilized two rows of holes that practically removed the bench and left the quarry with a neat shear face about 400 ft. high.

Handling of 500 lb. bits made easy

The quartzite rock of the Fontana quarry contained about 80 percent of silica and the abrasive action of the material caused rather heavy wear on the 9-in. dia. drill bits. An average of 5 ft. of hole was obtained from each bit before resharpening. A bit sharpening shop, above the quarry, was equipped with two sets of drill-dressing equipment. Each set included a 4-bit, oil-fired, forging furnace; a bit-dressing machine that formed and gauged the bit head; an oil-fired, tempering furnace with capacity for two bits; and a quenching tank with bit cradles.

Planned routine saves work

The four pieces of equipment and the storage piles for unsharpened and sharpened bits were arranged around a jib crane rigged with a chain hoist and bit tong. The bits weighing about 500 lb. each, were processed with a minimum of work by handling the sharpening in the following order:

1. *Unsharpened bit storage* to forging furnace
2. Forging furnace to bit dressing machine
3. Bit dressing machine to tempering furnace
4. Tempering furnace to quenching tank
5. Quenching tank to *sharpened bit storage.*

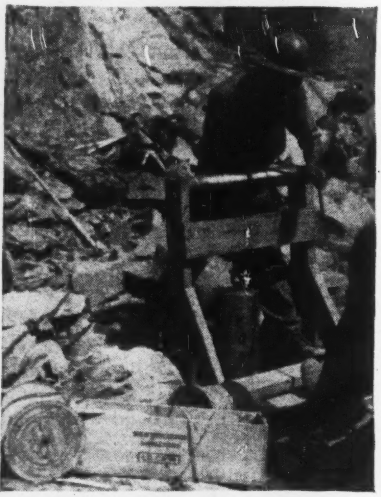


Fig. 4. A 53-lb. sealed metal container of explosive is lowered 325 ft. into blast hole. Note self-releasing hook.

Two blacksmiths with two helpers could dress 50 bits with these facilities during one 8-hr. shift.

Bits were handled from the drills to the sharpening shed on a small car with space for eight bits at a time. The car operated on a 15-lb. narrow gage track leading from under the jib cranes in the bit shop down the quarry site, branching through switches to various points along the drilling levels. The car was maneuvered by cable, controlled through a single drum hoist.

Utility lines underground

An air line, a water line and a power transmission line were laid around the perimeter of the quarry, being served at the floor level by a supply coming from each end of the quarry. Thus, these utilities were always available and if service was interrupted at any location it could be restored promptly to all other locations by isolating the one section. Wet drilling was employed to suppress dust from the rock, which contained silica.

Power for shovels was supplied at 2,300 volts from five buried terminal points at stations along the front edge of the quarry floor which could be fed from one of two circuits. Rubber-covered, grounded power cable ran from the terminal points along the quarry floor direct to the shovels. The power cables together with temporary air and water lines were originally supported over truck roads by wooden A-frames built on skids to facilitate moving. Removing these utilities from the A-frames for protection during frequent secondary blasts proved slow and costly and was soon displaced by carrying such services under roadways through openings made by drain tile. The quarry was operated on three eight-hour shifts and at night all areas were illuminated by flood lights supplemented by local lighting at points of greatest activity.

All primary blasting was done with a special material termed "Nitramon." which is very powerful but relatively safe to handle because it cannot be detonated by ordinary means. On occasions during loading, well drills were placed over partially loaded holes and used to force the explosive past obstructions without setting off the charge. This material came packed in 53 lb., sealed metal containers (8 in. dia. x 21 in. long) with a small bail in the top. In loading, the containers were lowered into the well drill holes with ropes, to which were attached self-releasing hooks. The loading operation was facilitated by the use of wood loading racks placed over the holes.

The explosive was detonated by special primers similarly packed in sealed metal containers. The primers were spaced at various intervals throughout the charge and were connected with reinforced primacord. The various charges were connected with a bus to which was attached one electric blasting cap with lead lines to an electric switch.

Careful records were plotted on each hole to determine the exact depth and burden, for selecting the proper quantity and arrangement of blasting material in each hole. The holes were stemmed with sand from 25 to 40 ft. at the top and were sometimes deck loaded by stemming between cans to reduce the charge at apparent weak points. The largest blast set off contained 208,000 lb. of explosive, which produced more than 600,000 tons of rock. The average yield in primary blasts was about 3.2 tons per pound of explosive.

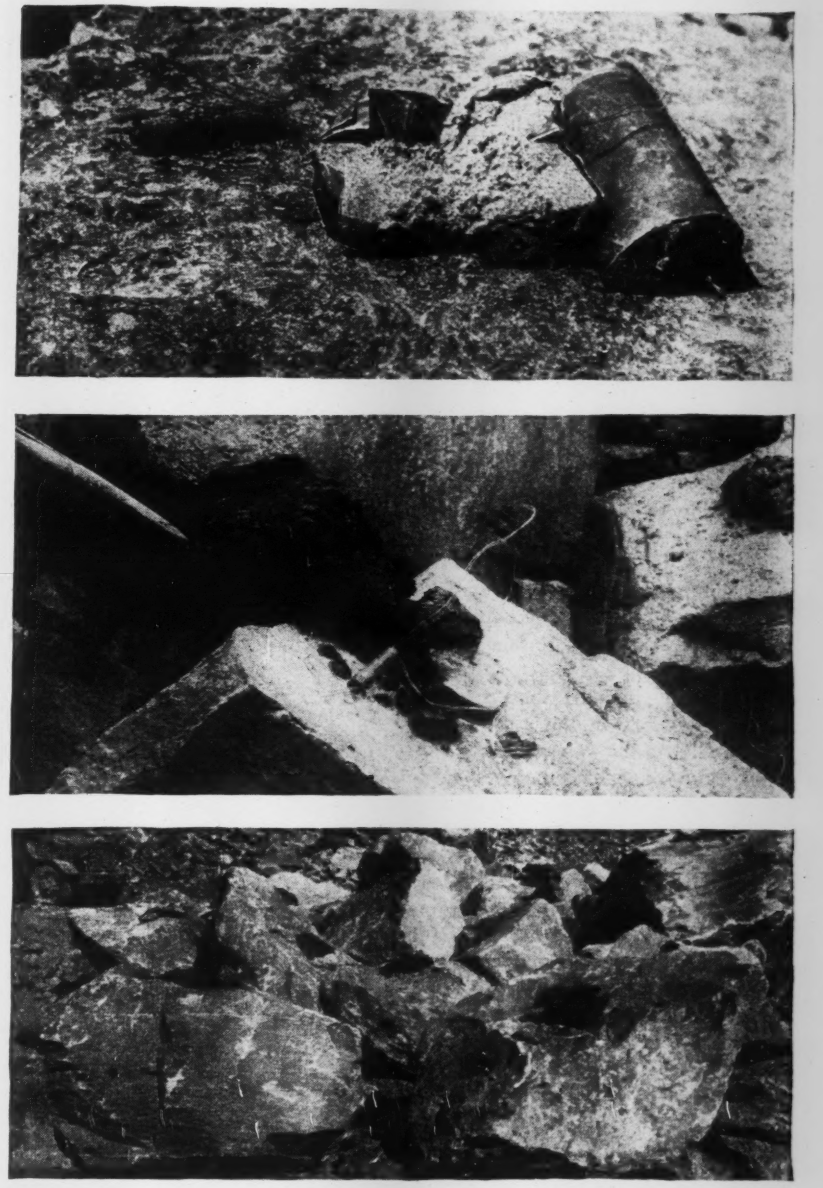


Fig. 5. Secondary blasting was done largely by "dobying" at about same cost but with much less labor than customary block-holing. Large cartridges of 40-percent gelatin were plastered on rock then covered with clay mud-cap.

Secondary breakage by "dobying"

Breakage from primary blasts was generally good. However, for all materials to enter the 42-in. primary crusher it was necessary to perform some secondary blasting on oversize boulders. At the beginning, secondary blasting was done by the usual "block-hole" method of drilling with jackhammers and loading with a small charge of 40-percent ammonium gelatin dynamite. Manpower was conserved, however, by reviving the art of "dobying," since there were no buildings near the quarry that might be damaged from accompanying concussions. Dobying is accomplished by placing a charge of dynamite (about 1 lb. per ton of rock) on top of a boulder, inserting an electric blasting cap and covering the charge with a plastic clay mud-cap of thin putty consistency. This practice, while demanding more explosive, required considerably less labor with no drilling expense and resulted in practically the same cost as block-holing.

Dobying had the decided advantage of speeding up production in the restricted working area of the quarry floor as a small crew could keep all over-size boulders broken up by setting off doby shots at shift change and lunch time on each shift. Forty-percent ammonium gelatin dynamite was used for the majority of such shots. High-velocity 60-percent gelatin dynamite was tried but no perceptible advantage was observed. Experiments did reveal that dynamite packed in 5 x 12-in. cartridges was most convenient for dobying. A thin paddle, fashioned from wood was used to cut a slice from the cartridge and flatten it on the rock even when the face of the rock was tilted to a steep angle. This method of placing doby charges proved to be far superior to "stacking" smaller size sticks and also required less dynamite.

Rock was loaded by five 4-cu. yd.

crawler-type, electric-powered shovels equipped with 3-cu.yd. dipper buckets. The small bucket decreased the strain on the machine and aided in sizing material to that which would enter the primary crushers. Mechanical water sprays were mounted on each shovel for wetting rock continuously and thoroughly during loading operations to control silica-dust.

A fleet of fourteen 10-cu.yd. dual-wheel, rear-dump trucks conveyed muck from the shovels a distance of from 400 to 1,200 ft. to the primary crushers. A bulldozer was available to keep the quarry floor clean and truck roads smooth, which permitted high-speed operation to be maintained.

Despite a restricted quarrying area and the exceptionally hard and abrasive rock the production shown in the accompanying table was made.

All aggregate processing equipment was in duplicate. Materials moved on dependable belt conveyors through the aggregate plant storage, reclaiming and delivery to the mixer plant, then finally, to the dam as mixed concrete. Use of belt conveyors made possible utilization of space for plants and storage that would have been impossible by other means of transporting materials. Altogether there were 39 separate flights of belt conveyors totaling more than two miles in length and up to 42 in. in width and 900-tons per hr. capacity.

Rubber-covered belting of stepped ply fabric or cord type construction was used. Three-roller troughing idlers were used throughout with single-roller return idlers. Rubber-covered disc idlers were mounted under the belts at loading points where greatest rock impact occurred. Self-aligning guide idlers were used at intervals on the suspension bridges. Head pulleys were driven through speed reducers, operating in conjunction with sprockets and roller chains driven with electric motors. Push-button stations were provided at various points along the system to permit stopping automatically all conveyors in a series feeding any flight.

Capacity of 900 ton per hr.

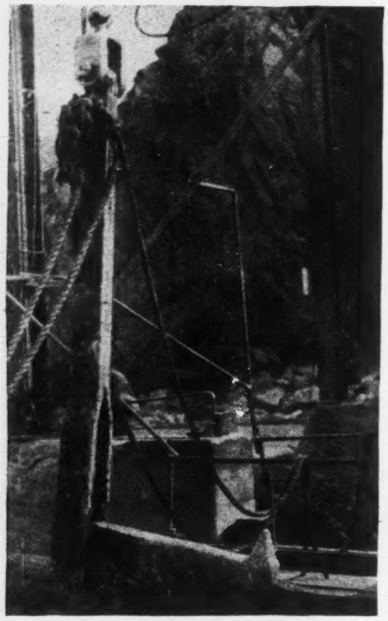


Fig. 6. Power operated, hinged hook suspended over crusher was used to move rock to break up wedging and choking. Controls were placed above crusher so operator had full visibility to maneuver the hook.

Initial processing at Fontana was done by two 42-in. gyratory crushers arranged side by side in a concrete structure at the upstream end of the quarry. Each crusher, powered by a 250-hp. electric motor, had a rating of about 450 tons per hour. Discharge openings were set at about 4¾ in.

In order that the big crushers might be above water, and yet not require an approach ramp for charging, the elevation of the quarry floor was established at 57 ft. above the river level. Truck access from two sides was provided for charging each crusher and the four dumping spaces were provided with timber guides to facilitate spotting trucks. A signal system consisting of four lights was used to dispatch approaching trucks to the appropriate dumping stall. On the day of maximum production 1,586 loads were handled by these crushers at an average of 442 tons per hour for each machine.

PRODUCTION AT THE FONTANA QUARRY

Month After Start	Monthly Production—Tons
1	80,000
2	120,000
3	200,000
4	240,000
5	300,000
6	347,000
7	383,000
8	386,000
9	349,000
10	257,000
11	91,000
12	232,000
13	328,000
14	380,000
15	399,000
16	462,000
17	372,000
18	360,000
19	194,000
20	76,000
*	350,000
	6,006,000

*Unprocessed—Stored for rip rap, backfill, etc.

The crushed rock fell into a hopper from which a vibrating feeder loaded it on a 42-in. conveyor belt having a capacity of 900 tons per hr. for transport across the river on a suspension bridge where it was discharged on a ground storage stock pile. This primary stock pile had a normal capacity of 35,500 tons and a live storage of 10,000 tons. Additional dead storage, as much as 120,000 tons of rock, was developed by spreading with a bulldozer to help balance the operations during periods of preparation for primary blasts.

Screening and crushing

The aggregate plant for the next operations of processing was arranged along the foot of the canyon wall upstream from the primary stock pile. A 42-in. belt conveyor under the primary stock pile carried rock to the top of the first crusher building, where the load was deposited on two double-deck, dry-scalp, vibrating screens that were mounted back to back. The top screens had 6 x 7½-in. openings and the oversize rock was passed by chutes to feed two 4¼-ft. standard cone crushers. The lower decks were equipped with screens having 3¼-in. sq. openings; all rock retained on these screens was classed as cobble material.

The desired quantity of cobble stock was taken off and fed to a 36-in. conveyor that transported all material selected for finished products, except sand, direct to the final screening plant. Any excess of material retained on the 3¼-in. screens was passed by chute to the standard cone crushers. These crushers were set with about 1½-in. openings and the product was recirculated to the scalping screens just described. All "throughs" from the 3¼-in. screens passed by chute to a 36-in. conveyor that delivered it to the top of the next crusher building.

The second crusher building was arranged similarly to the building just described except that the double-deck. vibrating screens at this point were equipped with wire cloth having 1⅝ and ¾-in. openings. The desired quantities of these sizes of rock were taken off the respective screens and fed to the conveyor leading direct to the final screening plant. Any excess of either size of the material retained on these screens was passed to two 4-ft. shorthead cone crushers. All "throughs" from the ¾-in. screens and the product of the shorthead cone crushers, which were set at about ¾-in., passed by chute to a 30-in. conveyor that delivered it to a point above surge bins at a rod mill for manufacture of sand.

Over the surge bins were located two single-deck, vibrating screens usually equipped with wire cloth having ¾-in. openings. The material retained on these screens was fine rock stock and the desired quantity of this material was likewise taken off and fed to the conveyor leading direct to the final screening plant. Any excess and all "throughs" at this point dropped into two 250-ton surge bins to provide stock from which sand was manufactured.

Up to this point, crushing of all coarse aggregates was completed and suitable feed was provided for the sand plant. The arrangement, with double installations of crushers and screens throughout the entire aggregate processing plant, gave a high degree of flexibility so that as changes in needs for different sizes arose, diversion of almost any size or quantity could be made to meet the new requirements and keep final stocks properly balanced.

Either set of screens and crushers could be operated independently or both sets used concurrently. Cobble manufacture was occasionally discontinued and at times neither cobble nor coarse rock was made. Only a very small portion of medium and fine rock was made occasionally and the provisions would have permitted complete discontinuance of this material if necessary. Actually, sand alone or sand and any portion of either of the larger size aggregates could be manufactured in this plant.

At the primary crushers, the tunnel under the primary storage pile, and in the two secondary crusher bulidings and at the surge bins, installations have been made to trap the silica dust. Roto-clone wet-type dust collectors accumulate all dust from feeding and screening operations and deposit it in water, which is wasted in the river.

Aside from the overall flexibility desired, one of the main purposes of the preliminary screening and secondary crushing installation was to prepare material for sand production. This storage of feed material in surge bins permitted manufacture of sand even when the remaining plant was shut down and likewise the sand plant need not necessarily operate when the remainder of the plant was running.

It was intended generally to use a ¾-in. size product to feed the rod mills, however, screen sizes were changed to meet conditions in sand production and sometimes ¼ x ⅝-in. screens were used permitting material less than ¾ in. to be included in fine stone. Vibrating feeders located under each surge bin fed 24-in. conveyor belts serving two 9-ft. dia. by 12 ft. rod mills, which were driven through V-belts by a single 800-hp. electric motor. Each rod mill carried a 78,000-lb. charge of 3½-in. dia. by 11½-ft. steel rods. Water was added to the mills roughly in the proportion of 30 percent to 70 percent of feed by weight. The water was regulated so as to control the discharge and give the desired grind; insufficient water gave too many fines.

Under normal operations, producing about 100 tons of sand per hour, rod consumption averaged about 0.8 lb. per ton of finished sand. More than 1,500,000 tons of sand was manufactured at Fontana by the method described. The sand thus produced was neither excessively sharp nor excessively rounded, but it made an easily workable concrete mix.

In production of sand, some "slimes" or excess fines were produced, which were subsequently wasted in the classifying operation. At Fontana 16 percent of the rod mill feed was lost in this manner. No provision was made for recirculating oversize products from the rod mills, so all grinding was completed in one operation. The discharge from each rod mill was collected in a flume going direct to a 16-ft. dia. by 5-ft. hydro-separator where additional water was added and the sand agitated, causing slimes to rise and overflow to waste with the effluent. The underflow from the hydro-separator was split and passed to a 5 x 30-ft. and a 7 x 30-ft. rake classifier where slimes were further removed by overflowing to waste with the effluent.

The solids constituted finished sand, which was deposited on a 30-in. belt conveyor and transported to storage. The arrangement of the rod mills, hydro-separator, and rake classifiers in successive steps down the profile of the mountain permitted the wet material to flow by gravity in the sand production processes.

Storage in a natural ravine

A deep ravine, situated just upstream from the aggregate plant, offered the only suitable space for storage of any quantity of finished aggregate. However, this valley had a steep gradient and drained a large

Fig. 7. Hydro-separator for dewatering discharge from rod mills and rake classifiers used to remove excess fines from sand manufactured at job.

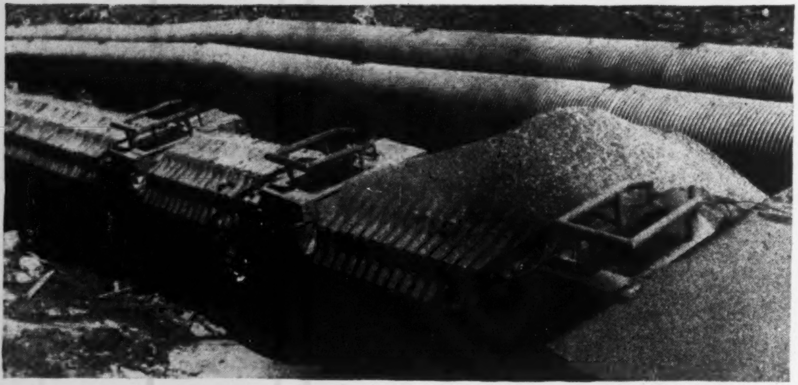


Fig. 8. Sand and fine aggregate outlets in reclaiming tunnel were equipped with steam coils to prevent freezing of materials in extreme weather. Corrugated pipes carry water from natural watercourse displaced by tunnel.

area through a constant flow creek. A concrete headwall was constructed at the upper end of the area and the creek water diverted was carried through two 48-in. corrugated galvanized steel pipes. A reclaiming tunnel constructed of laminated timber ran the entire length of the storage area and a retaining wall of timber cribs supported sand storage at the lower end of the storage area. Loading gates and chutes were provided under each stock pile and steam coils were installed at the sand and fine rock openings to prevent freezing and crusting in extreme weather.

Sand conveyed from the rake classifiers, containing about 20 to 25-percent moisture, was placed in the storage pile by a 110-ft. radial stacker swinging through an arc of about 60 deg. This stacker could be moved by a geared hand crank, allowing storage of sand in one portion of the pile while it was being drawn from another portion thus permitting some dewatering of the sand by natural drainage. However, much of the drain water percolated through the laminated timber tunnel and a system of well points was run through the top of the tunnel into the sand to intercept the water.

All the crushed stone not used in sand production was delivered to the storage area on a 36-in. belt and separated into four sizes of aggregate by three sets of single-deck, vibrating screens, in duplicate pairs, mounted back to back in timber structures. The flow of materials in final screening paralleled the direction of the storage area. The first set of screens separated cobbles (6 to 3 in.) which were discharged onto two 30-in. belt stackers mounted at right angles to the general flow of materials. The "through" material from the cobble screens flowed by conveyor to the next set of screens where coarse rock (3 to $1\frac{1}{2}$ in.) was separated and handled over two stackers to the stock pile. Medium rock ($1\frac{1}{2}$ to $\frac{3}{4}$ in.) was similarly separated and stored. The remaining material, "throughs" from the $\frac{3}{4}$-in. screens constituting the fine rock, was conveyed to the place of storage over a 24-in. conveyor and stacker.

Aggregate from storage was reclaimed by gravity flow to a conveyor belt in the tunnel under the storage, controlled by manually-operated gates. Light signals from the mixing plant, determined the type of material desired and the length of the loading period. The conveyor from the reclaiming tunnel delivered material, over a second suspension bridge, to the rinsing screens. All material except sand was directed over two rinsing screens where a heavy water spray thoroughly removed all fine material from the stone as it passed on its way to the mixing plant. Fine material, rinsed from the stone, was diverted by flume to a sand rewasher where is was dewatered and stored. The reclaimed sand was used for miscellaneous purposes about the project and any excess was trucked across the river to the sand storage.

There was a by-pass at the rinsing screens where sand or stone could be sent by conveyor to a bin over an auxiliary batching plant having a capacity of 2 cu.yd. Material could be batched to transit mixers for miscellaneous small concrete requirements without interfering with the continuous operation of the central mixing plant.

The layout and operations described in this article gave excellent results in supplying material for the 2,800,000 cu. yd. of concrete for Fontana Dam. From the single plant, equipped with five 4-cu.yd. mixers, a maximum of 241,211 cu.yd. of concrete was produced in a single month, 10,755 cu.yd. in one day and 3,828 cu.yd. of concrete on one 8-hr. shift.

All engineering and construction work was carried out under the general supervision of C. E. Blee, chief engineer, and A. L. Pauls, chief construction engineer of TVA. Frederick C. Schlemmer is project manager at Fontana Dam assisted by Oren Reed, construction engineer, G. E. Murphey, construction superintendent, and W. R. Johnson, materials engineer. W. D. Simpson supervised quarrying and H. D. Irvin supervised operations of the aggregate processing equipment. R. T. Colburn is construction plant engineer of the Tennessee Valley Authority.

Fig. 9. Fixed stackers carry processed aggregate to storage. Stacker for sand, at right, may be rotated.

Areal Subsidence at Long Beach Has Reached a 4-ft. Maximum

Subsidence of the earth's surface over an area of many square miles and continuing over a long period of years is being recorded and studied at Long Beach, Calif. While the rate has varied in different localities and in any one locality at different times, maximum total subsidence in recent years has been on the order of 4 ft.

It is a significant fact that for months after each of two earthquakes that have occurred in the past few years on the nearby Inglewood fault, the otherwise more or less continuous rate of subsidence has temporarily stopped. This result of earthquake shock, now observed twice, is taken to indicate tectonic origin of the subsidence. Previous reference to earth movement at Long Beach was reported in *ENR* Mar. 26, 1942, vol. p. 477.

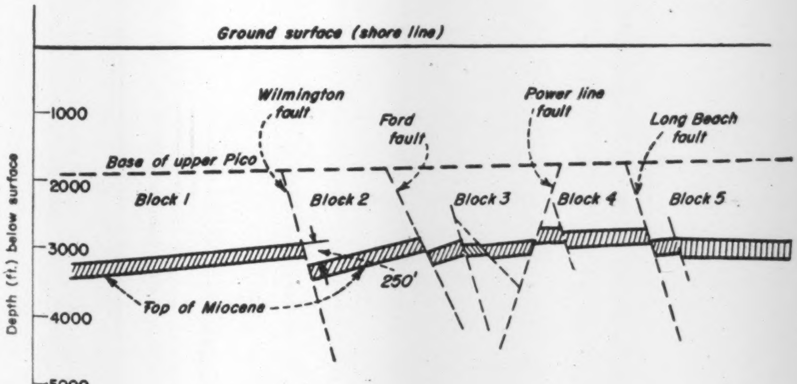
There is no record of surface movement here prior to about 1924. Then, for some 14 yr., the total result was little more than an unstable and unreliable level of bench marks. Variations were small. In 1938, however, the movement became a consistent subsidence that in a few years totaled enough to be quite noticeable in street grades and where structures are referenced to water level, as on wharf decks. In 1944 the subsidence was at the rate of 0.5 ft. per year in some areas until the time of the November earthquake that put a stop to cumulative movement.

The subsidence has occurred chiefly along the ocean shore beginning in San Pedro and extending eastward well beyond the center of the Long Beach business district. Maximum subsidence is on the ocean shore near the center of this zone, the rate decreasing toward the outer edges of the roughly semi-circular land zone affected. The total area involved is about 40 sq.mi., of which about 16 sq.mi. near the center has subsided 6 in. or more in the 20-yr. period. The point of maximum subsidence, now about 4 ft. below grade, is on the ocean shore south of the turning basin of Long Beach inner harbor, close to the western end of the floating drawbridge described in *ENR* June 14, 1945, vol. p. 838.

The city of Long Beach, particularly the harbor department, has long been cognizant of this tendency to settle and has anticipated the result on waterfront structures in the zone of heavy subsidence by making allowances, namely, by building wharf decks and other structures as much as 2 ft. above grade.

The accompanying vertical section through earth strata underlying the subsiding area is taken from a 1943 report of the California State Mining Bureau. Cross-sections of this sort can be made accurately in this area because of the proximity of many oil wells whose logs give comprehensive and detailed information about subterranean strata. The four faults shown are close to the center of maximum subsidence. It is considered significant that where they cut across the top of the Miocene zone some 2,500 ft. below the surface, the blocks between faults have slipped downward by amounts in some places exceeding 200 ft.

These data make the subsidence so definitely a geological matter that the city of Long Beach has engaged a board of three geologists to study and report on the situation. The city is also cooperating on investigations undertaken by the county and the U. S. Coast & Geodetic Survey. A net of precise levels is being run to check previous surveys and establish points for further reference.



Vertical section through earth strata underlying a portion of Long Beach showing subsidence of great depths. (From Bulletin 118, Calif. State Mining Bureau.)

New Well at Houston Produces Record Flow

Furnishing a flow of 5.2 mgd. under its initial test, a gravel-packed well at Houston, Tex., is reported to be the largest producer ever drilled in this area. The well is one of six recently installed by the Layne-Texas Co. to augment the municipal water supply.

Three of the wells have been tested and found to produce 4.4, 4.5 and 5.2 mgd. respectively. The 5.2 mgd. production is the greatest of any water well ever drilled in Houston, according to J. B. Dannenbaum, San Jacinto water project office engineer at Houston. He said Houston would have plenty of water this summer because of the new wells. Shortage of water at Houston last summer caused water to have to be rationed as well as the city's buying what was possible from adjoining suburbs. Mains are now being laid to carry the water from the new wells into the city water distribution system.

On May 3 the city council of Houston apropriated $50,000 to defray engineering supervision and other noncontract costs of the $1,651,000 worth of water improvements now being made at Houston. This $50,000 includes $20,000 for engineering supervision; $17,500 for connecting the lines the contractors laid; and $12,500 for testing and chlorinating lines.

These improvements form part of Houston's proposed $14,000,000 water supply expansion program.

Establishment and Maintenance of Cover On Unpaved Surfaces of Airports

Lt. Col. R. H. Morrish
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Contents in Brief*—Good drainage, proper fertilizer and timely planting of well selected grasses is the most economical method of keeping the huge unpaved areas of airports free from dust and mud. Early fall planting gives best results in most northern areas while spring seeding is best where winters are mild. Good grass cover absorbs the rain, prevents gullying and protects the entire surface. For places where grass won't grow, alternative means for protection are suggested.*

PAVED RUNWAYS, taxiways and aprons of commercial airports seldom constitute more than 12 to 16 percent of the airfield's surface. Thus some 85 percent of the area of many fields and the entire surface of others, used primarily for private flying, have other than hard surfaces. Such surfaces are economically provided in most cases by sod, though in some area sod-forming grasses are not adaptable and other types of vegetative cover can be used. Straw mulches, oil palliatives, gravel blankets and other treatments have been applied where vegetation cannot be established readily because of climatic or soil conditions.

There are innumerable grasses and other types of vegetation useful in stabilizing the surface of the soil to prevent dust, mud, drifting sand and erosion. There are northern grasses, southern grasses, grasses for humid areas, dry areas, salt-spray conditions, wet soils, alkali soils, sand dunes and the like. Each type has certain strong points that qualify it for the particular use required. Valuable technical assistance in the establishment and maintenance of vegetative cover on airfields is available through the U. S. Department of Agriculture, the various state agricultural experiment stations and other established agencies.

What and when to plant

In the Pacific Northwest and in all of the northern states east of the Great Plains, where rainfall is adequate and fairly well distributed, perennial grasses are most satisfactory. The establishment and maintenance of ground cover in these areas is not an especially difficult job if seedings are made by proven methods and at the proper time. Kentucky blue grass, bent grasses, fescues and red top can be made to grow with ordinary

Dust from an Army airfield makes life miserable for men and shortens the life of machines.

are although their rapid establishment on sterile subsoil material requires careful soil preparation and heavy fertilization. Early fall seedings of grasses are generally most successful in these areas, however, early spring seedings may be satisfactory if the late spring and summer rainfall is adequate.

In southeastern and south central United States, Bermuda grass, established vegetatively by sprigging, has proved to be particularly valuable in airport construction. Bermuda grass is truly a heavy duty perennial type of vegetation. It thrives under widely varying conditions of soil and climate, which accounts for its wide distribution and extensive use throughout the south and southwest. Bermuda grows satisfactorily in the Piedmont region, in the lower Mississippi Valley, and equally well in the coastal plain.

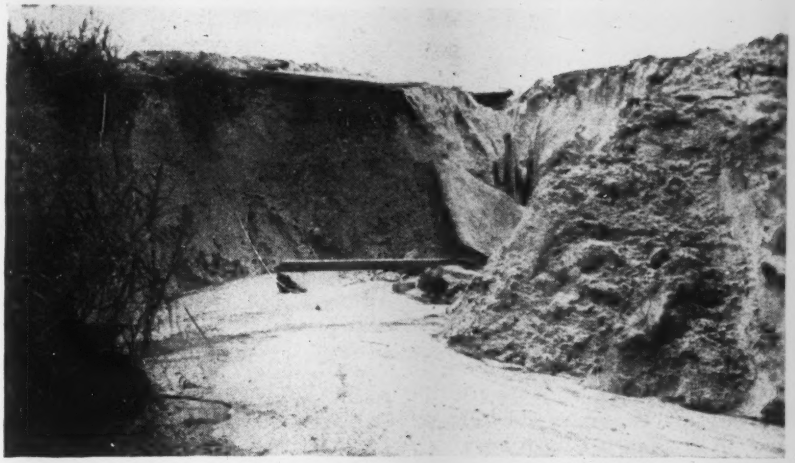
Well established Bermuda sod will carry 8 cfs. of water in a 2-ft. channel having a slope of 10 percent for a period of 60 min. without suffering appreciable damage. However, carpet grass sod is preferred for outfall ditches at some military installations of the coastal and southern areas.

Buffalo grass for Great Plains

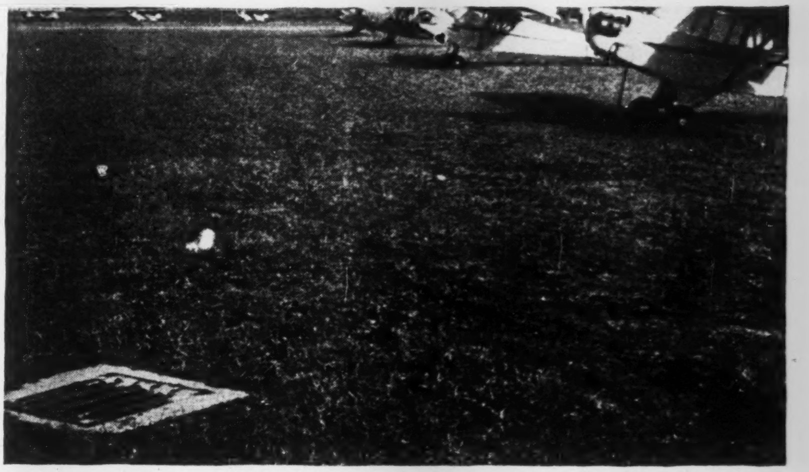
The grasses that appear to be most promising for the Great Plains and semi-arid regions of the mountain states are buffalo or buffalo and blue grama for the entire short-grass country; smooth brome grass in areas with good soil, receiving 20 in. or more of rainfall, especially if maintenance is apt to be neglected; and crested wheat grass for the northern plains area on most soils and under normal moisture conditions.

Mixtures of grasses generally are preferred but they should be limited to those species that have the same general growth requirements and characteristics under a given type of maintenance. For example, buffalo grass and blue grama make an ideal mixture while buffalo and western wheat compete with each other. Rates of seeding should be consistent with the moisture supply and fertility of the soil.

Buffalo grass is one of the most desirable native species for airfields and other areas subject to intensive traffic. It is a spreading, sod-forming short grass capable of surviving periods of prolonged drought.



Unchecked erosion on sandy soil resulted in this condition on a Florida airfield.



Good sod cover resists washing, even at drains, will stand a great deal of use and will prevent gullying.

Means recently have been developed to improve germination of buffalo grass seed. One process is to soak the seed for 24 hr. in a 2-percent solution of potassium nitrate and then refrigerate it for four weeks at a temperature of 41 deg. F. prior to planting. This treatment increases germination from 10 percent or less to 80 percent and in some cases as much as 90 percent at a cost of about 2½ c. per pound. Buffalo grass seed, removed from the burr by a hammermill, has germinated 70 percent in 8 days compared to 13 percent in 14 days when left in the burr.

Annual grasses for dry areas

In the extremely dry areas of the Southwest, including southern California and some of the inter-mountain areas, annual grasses such as cereal grains are used where practical to provide a quick, temporary cover to control dust and water erosion on unstable soils until slower growing perennial grasses can become established and take over for permanent dust control. In some limited areas, annual grasses are planted each year as the best cover available for airports.

When using cereal grains in seedings with perennial grasses, the amount of seed used in a mixture should be limited to 10 to 15 lb. per acre in low rainfall regions so that the hardy grain plants will not rob the perennial seedlings of the limited available moisture. The cereal grain should be mowed during the early spring before it goes to seed and before the soil moisture is exhausted, to permit the perennial grasses to become well established ahead of the summer dry season.

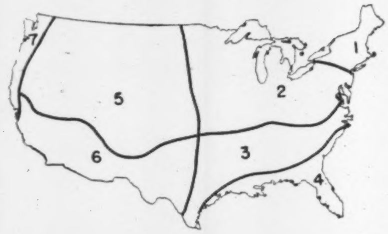
Straw mulch stops blowing

In regions where the annual rainfall is 10 in. or less, it is considered essential to apply straw or hay mulch to light, sandy and other unstable soils to control dust and water erosion. The ultimate objective of mulching in these regions is to establish vegetation by catching and retaining a large portion of the annual precipitation. The straw mulch reduces soil moisture evaporation, and thus greatly increases the chances of obtaining a stand of grass in a hot, dry region. The mulch is spread by a recently developed machine that distributes it evenly at the rate of about 2 tons per acre, following which it is punched into the soil with a disk harrow, a curved-tooth rotary hoe run in reverse, or similar equipment. Seedings of adapted dry land grass species should be made at the time the mulch is applied or later at the proper season. Mulching has been used economically in the establishment of permanent cover in some of the slightly higher rainfall areas.

In some areas of the southwest and west it has not been practical to attempt to establish vegetative cover, and other methods of dust control including oil palliatives have been used.

The oil palliative used most extensively is the standard MC-1, medium cut-back oil. Essential steps in application are light scarification, rolling of the area, watering with 1 to 1½ gal. per sq. yd. and applying 4/10 gal. per sq. yd. of the oil. The complete operation including cost of oil, averages from $350 to $450 per acre.

Irrigation of airfields in some areas of limited rainfall has been found to be economical. On some fields auxiliary to major air force training stations the overall irrigated field has proved more economical and satisfactory than comparable fields with surfaced runways. The cost of installation of irrigation equipment is less than for the cheapest paving. Maintenance has been less expensive on the irrigated field than for a paved runway field carrying the same amount of traffic of approximately 650 landings per day. In addition, when such fields are released from military use, the irrigated fields will have incomparably greater value for reconversion to agriculture than the fields with extensive paved surfaces.



GRASSES AND LEGUMES GENERALLY ADAPTED TO THE DIFFERENT REGIONS OF THE U. S.

Region 1

Fescues
Colonial Bentgrass
White Clover
Red Top

Region 2

Kentucky Bluegrass
Fescues
Quackgrass
Canada Bluegrass
Smooth Bromegrass (North)
White Clover
Annual Lespedeza (South)

Region 3

Bermuda Grass
Redtop
Annual Lespedeza

Region 4

Bermuda Grass
Carpet Grass
White Clover

Region 5

Wheat Grasses
Grama Grasses
Buffalo Grass
Sand Dropseed
Indian Ricegrass
Curley Mesquite
Smooth Brome

Region 6

Sand Dropseed
Alkali Sacaton
Grama Grasses
Bermuda Grass
Bur Clover

Region 7

Fescues
Colonial Bentgrass
Kentucky Bluegrass
Perennial Ryegrass
White Clover

ESTIMATED RUNOFF FROM VARIOUS SURFACES

Asphalt pavement (good)	85 to 90%
Concrete pavements, with filled joints	75 to 85%
Compacted bare ground	*60 to 65%
Cultivated ground	*40 to 50%
Thin sod cover	*30 to 40%
Anchored mulch (2 tons per acre)	*10 to 20%
Dense sod cover	* 5 to 10%

* Depends on degree of slope, character of surface and sub-soil.

Nitrogen fertilizer needed

The application of adequate quantities of the right analyses of fertilizers is one of the most important practices, in humid areas, in establishing, improving, and maintaining grass sod. Grass grows vigorously, dominates most weeds and forms a thick sod if it is well fed. High nitrogen fertilizer should be used to start and maintain a grass sod free from weeds but phosphate and potash are usually essential, especially in building up the fertility of some of the sterile subsoils. High analysis fertilizers cost less per unit of plant foods than do low analysis grades.

Regions with less than 2[illegible] in. of rainfall do not usually need complete fertilizers since moisture is the limiting factor in plant growth. However, this is not necessarily true where all of the top soil is removed, and the establishment of cover is required on barren subsoil. Recent results indicate that limited applications of nitrogen at seeding time are beneficial in some of the low rainfall areas.

Fertilizer added periodically

Fertilizer should be applied before or at the time of seeding, utilizing the grain drill to place seed and fertilizer at the optimum depth for best germination. Continued use of fertilizer is necessary, particularly in heavy traffic areas along the runways and where planes may move over the grass areas near the aprons. Additional fertilizer, as needed, can be spread with a fertilizer drill and should be applied at least annually. Some tests indicate that the same total amount of nitrogen added spring and fall gives substantially better results.

Numerous different analyses of fertilizer are available and it is desirable to obtain complete soil analyses as guides to indicate the plant food deficiencies in the soil. Lime frequently is desirable for use on acid soils but should be used only where tests show that it is required. When the grass becomes thick enough to provide a dense, wear-resistant cover it may be desirable to reduce the amount of nitrogen feeding, thus reducing mowing costs and making the plants tough and resistant to heavy use.

At Patterson Field, Ohio, 1,200 lb. per acre of 10-6-4 fertilizer was applied on strips, 175 ft. wide on each side of runways, taxiways and aprons and 600 lb. per acre of 10-6-4 on the balance of the field with a top dressing of 1,000 lb. per acre of a sewage disposal plant byproduct. Complete blue grass cover was established in one year on all critical areas and the whole field attained complete coverage in the second year, with added nitrogen applied as a maintenance operation.

Fertilizer versus topsoil

Topsoil and natural ground cover should be conserved wherever possi-

To stop sand from blowing on New York's new 4,500-acre Idlewild Airport, beach-grass is transplanted into the hydraulic fill sand and gravel. Sprays are planted 18 in. apart each way, being set by hand into furrows 9 in. deep opened up by runners of this 6-row machine.

ble during construction of an airport. However, where it is necessary to stockpile or borrow topsoil it sometimes is more economical to build up a sufficiently good soil from the subsoil by use of fertilizers. This method has an additional advantage in that the weeds and foreign material in the existing cover are destroyed and a new start can be made with the most desirable grasses.

Equipment needed for seed bed preparation on off-the-runway surfaces are disk harrows, soil pulverizers, and spike-tooth harrows. Plowing of newly graded areas should not be necessary.

For original planting a grain drill with grass seed and fertilizer attachment is desirable. Wheelbarrow and whirlwind hand-type broadcast seeders are used for reseeding small areas while the small trailer type distributor, drawn behind a truck, may be used for maintenance fertilizers.

Most of this equipment is of the common agricultural type, drawn by farm tractors, very little equipment having been developed primarily for airport work. However, pneumatic tired equipment is preferred to steel wheels and is becoming available.

Good drainage helps

Drainage of the area on which grass is to be grown is extremely important. A well drained soil encourages the growth of a healthy, drought resistant, vegetative cover. A well developed sod will absorb a relatively high percentage of surface water and still retain a wear-resistant surface.

On experiments with a "rain-making" machine a good grass cover absorbed ten times as much water as a thin sod. Thus, surface runoff factors for design of drainage systems are considerably affected by the type and density of cover that can be established on an airport soon after construction is completed. Provision should be made to take the water off, however, without running over grass surfaces, along runways and other extensive paved areas.

It should be emphasized that rapid runoff, with consequent erosion and gullying, is not confined to regions of relatively high rainfall. Flash storms in arid and semi-arid regions may cause serious washing in a relatively short time and small gullies in fresh fills may develop rapidly into deep channels. Paved gutters and water ways are necessary on some slopes adjacent to airfields but sodding has been found to be a more economical expedient under most conditions. Sodding is usually more effective on steep slopes than is seeding, although timely seedings of grasses when protected by mulching materials have resulted in the establishment of satisfactory cover on many cut and fill slopes.

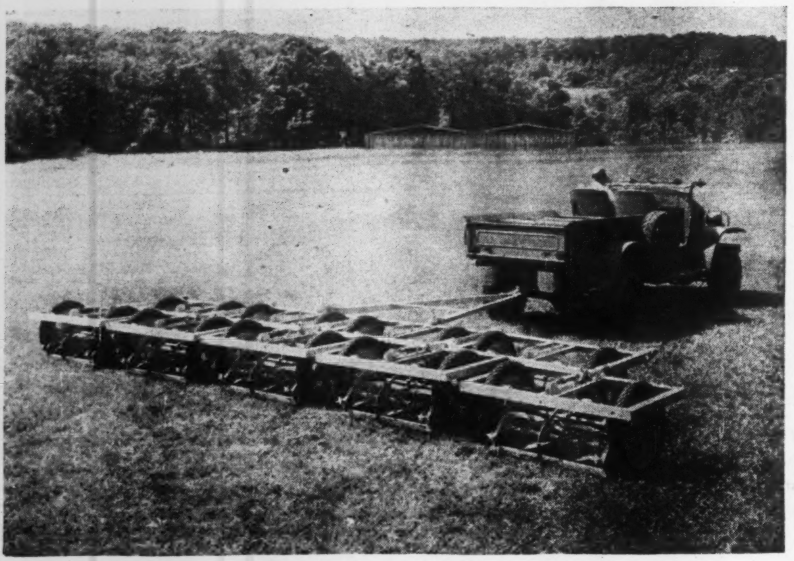
Let grass grow

Once grass cover is attained, mowing becomes essential to maintain a good sod. The frequency with which mowing is done will depend to a considerable extent on the fertility of the soil, kinds of grass and the amount of moisture. During a rainy period it may be necessary to mow as often as once in ten days, while at other times mowing may be put off for several weeks, except when used as a means of controlling high-growing weeds.

Blue grass should not be cut shorter than 2½ in. and should not be permitted to reach a height of more than 6 in. Bermuda and bent grasses should not be cut to less than 2 in. because of drought injuries that may result. To maintain a good sod, these grasses should not be allowed to reach a height of more than 5 in. Tall, hay type grasses such as brome and timothy, should be cut about 3 in. high after they have reached a height of 6 or 8 in.

Clippings should not be removed from the ground as they contain large quantities of plant food. However,

Traffic control as well as proper seeding and fertilizer is necessary to secure and maintain a grass cover on airport surfaces.



A single nine-gang mower, pulled at high speed by Army weapons carrier, will service up to 800 acres. Grass should be kept 3 to 6 in. high.

if clippings are heavy enough that they tend to smother the grass, they should be raked up and hauled away. This is an expensive operation and can be avoided by the timely mowing of the intensive and occasional use areas with high speed mowers designed for airfield maintenance.

Reel type gang mowers are most satisfactory for cutting large acreages because of the speed and efficiency with which they can be operated. A gang mower of this type, with 7 or 9 cutting units, will service as much as 600 to 800 acres. A tractor mower with a 5 to 6-ft. sickle-bar is necessary to cut tall grass and weeds and one should be available for each 250 acres of non-traffic area to be maintained.

It is of utmost importance for proper maintenance of cover on an airfield that a fixed permanent crew be maintained, whose duties are the maintenance of grounds. Such a fixed crew acquires pride and interest in their work and can be economically employed the year around. One full time man is required for about each 125 acres with a full-time foreman in charge of the work on each airfield. During winter months such a crew can handle snow removal.

Prestretched Reinforcement Makes Concrete Beams Stronger

To investigate the possibility of increasing the strength of concrete beams through the use of *prestretched* reinforcing bars, that is, ordinary commercial reinforcing bars that have been stretched far beyond the yield point, a series of experiments are being carried on by B. J. Lambert, professor of civil engineering, and Ned L. Ashton, assistant professor of civil engineering, in the Materials Testing Laboratory of the College of Engineering, State University of Iowa, at Iowa City.

In these tests, commercial reinforcing bars are stretched about 10 percent and released before placing in the concrete. Under ordinary circumstances, this stretching operation would be done at the rolling mill or warehouse, to a predetermined point. Beams tested have a constant width of 6 in., a length of 72 in., and nominal depths of 4, 6 and 8 in.

In the first series of tests 28 beams were made, using bars of three types. Each beam was reinforced with a set of three similar bars with standard hooks on their ends, and these bars, securely wired together, were placed 1 in. from the bottom on metal stools.

The reinforcing steel was of the following types:

	Stretching Load
1. Plain ⅜-in. round rods, hot rolled—42,000± at y.p.	42,000 to 52,000
2. Ordinary deformed ⅜-in. round rods—56,000± at y.p.	56,000 to 77,000
3. Special deformed ⅜-in. round rods—50,000± at y.p.	50,000 to 72,000

One half of the bars, 42 in number, were commercial bars, as ordinarily supplied. The other half of the bars were similar to the first, but were placed in the tension testing machine, stretched 10 percent over the original length and released. Then, the necessary length for the beam was cut off, standard hooks formed on each end and sets of three made up the same as for the ordinary rods.

Two types of loading were used—midpoint and third-point. Reaction shoes were placed on roller bearings to eliminate any horizontal thrust under excessive deflections.

Records of these model beam tests are now being plotted and studied. A report will shortly be completed, and the problem will then be set up for further review and study, looking to an extension of the investigation into full size beams and slabs.

So far the investigators are able to report that:

1. A 10 percent stretching of the ⅜-in. reinforcing rods increased the ultimate strength of beams by from 41 to 65 percent above the strength of beams using the same size and type of unstretched bars.

2. Since the stretched bar is 10 percent longer than the original bar, increased strength of beam is effected with a 10 percent saving in the weight of steel.

3. The dead load of the slab or beam can be materially reduced, because a thinner beam using prestretched rods is as strong as a somewhat thicker beam in which unstretched rods are used.

4. The moment resisting capacity of a beam, using either stretched or unstretched reinforcing, is much more dependent upon the quality of the bar than upon the kind of reinforcing lug.

5. Beams are much more elastic when stretched bars are used.

6. The proper percentage of stretching should be regulated by the characteristics of the steel—stretching should be stopped near the hump of the stress-strain curve.

Effect of Moisture on Compacted Soils Revealed by Laboratory Tests

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Austin, Tex.

Editor's Note—*Long interested in producing better and more durable soil support for pavements, the author has conducted many laboratory and field experiments to develop his theory that road and runway surfaces fail principally because of two factors that are neglected in design and construction. These are: failure to adequately protect clay soil under the pavement from subsequent detrimental changes in moisture content; and failure to properly consolidate the soil into an integral structure. The experiments described in this article seem to bear out his contentions.*

WHAT HAPPENS when moisture inevitably gets into a compacted clay soil subgrade under runway or roadway paving? Obviously a certain disintegration of the soil structure takes place, for that is an immutable law of physics. But how much and how seriously does such disintegration affect the compressive strength (bearing power) of the soil? Apparently quite a lot, according to the frequent failure of pavements on supposedly good clay subgrades that have become wet. Similar to any other structural material, the service rendered by clay soil in runway and road construction depends largely upon the continuing strength and durability of the material *in place*. Of course, it is well known that considerable initial compressive strength can be obtained in a clay soil by proper compaction, but few data are available as to the sustained bearing value of the soil in foundation service under varying moisture content.

Moisture content tested

To find the answers to these questions the author has conducted a series of tests on compacted clay soils under varying conditions of initial moisture content, degree of compaction and various stages of subsequent moisture content, including saturation. The results are interesting. They indicate the best thing to do is to keep water out of a clay subsoil as much as is practicable and next best is to make an engineering study of the available subsoil material and specify a combination of initial moisture content and degree of compaction that will produce a foundation material least susceptible to disastrous disintegration and corresponding loss of bearing value under subsequent uncontrollable changes in moisture content. If the studies show the available material incapable of treatment to assure continuous stability, then the engineer must make up for the soil weakness by designing a pavement rigid enough to properly distribute traffic loads over the subgrade.

Initial moisture and compaction

The tests also reaffirm the importance of the proper relation between initial moisture content and the degree of compaction to produce substructure material of highest possible compressive strength. One combination of moisture content and compaction force resulted in a sample with a compressive strength of only 41 psi., while a different combination, using the same soil, resulted in a bearing value of 202 psi., five times as much.

These and other laboratory experiments indicate that unless clay soils are consolidated into integral structures with known qualities, and those qualities subsequently maintained, the service that they render under pavements will vary accordingly to the amount of water they contain. On highways where appreciable settlement and extrusion in the subsoil has occurred under load, the indications are that: (1) the soil was in a disintegrated, "mushy" condition to begin with, (2) its structure had been broken, or (3) there was movement in the natural foundation.

When water percolates through a ruptured clay soil it always causes additional deterioriation. This is inevitable: for after the soil structure is ruptured its attraction for water and absorptive capacity are greatly increased. The detrimental effects of absorbed water on the stability of clay soil are well known, but confusion often is caused in this regard by delay in the appearance of these detrimental effects due to the time it takes for water to reach the ruptured clay soil in sufficient quantity to cause further deterioriation.

Two common causes of rupture in consolidated clay soils are: (1) rapid moisture content fluctuations in the soil structure, and (2) overloading. Joint pumping and pavement failure have resulted from exposing consolidated, damp and expansive clay to the elements—hot sun, dry winds, or sudden rainstorms—before the pavement was placed. In such instances disintegration of the soil structure had already started.

Loss of compressive strength

Compiled data also show that where free water comes in contact with a consolidated, integral soil structure for a sufficient length of time to cause saturation, considerable compressive strength will be lost during the time the soil structure is saturated, as much as 75 percent in some instances, even though the rate of absorption is not sufficiently rapid to rupture the soil structure.

Because rapid increase in mosture content ruptures a clay soil struc-

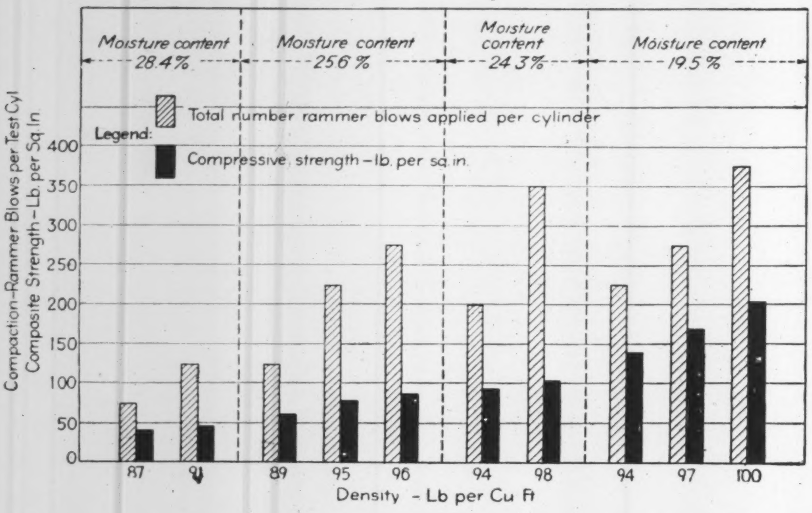


Fig. 1. Comparison of compressive strength of soil specimens in relation to various degrees of compaction and under several different moisture contents. Specimens, all of same soil, were loaded to failure immediately after compacting.

ture, and slow increase in moisture content decreases its compressive strength, the consolidated structure must be protected as much as possible from absorption of large amounts of water, including that from seepage and capillary action.

Usually, highly colloidal clays with high moisture content cannot be consolidated economically to sufficiently high unit compressive strength to carry maximum traffic loads. Under such conditions, the pavement should be designed with enough beam strength to distribute the loads over the subsoil to prevent overloading. The designer must remember that the vertical deflection in the pavement under load must not be as great as the vertical rupture-deflection of the supporting soil structure.

Experiment procedure

From one homogeneous sample of clay soil, two series of test cylinders, designated as *A* and *B*, were prepared with various combinations of soil moisture content and consolidation. The *A* cylinders were slowly loaded to failure immediately after they were consolidated; while the *B* samples, after being consolidated, were slowly wetted until they were saturated and then loaded to structural failure.

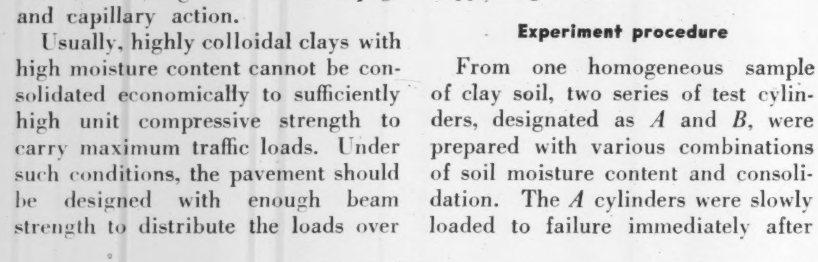
The main objectives in the *A* experiments were (1) to determine the relative compressive strength of the cylinders, and (2) to determine the amounts of vertical deformation in the soil when it ruptures, this test being made immediately after the cylinder, with its particular moisture content and compaction, was prepared.

The *B* experiments were made to determine: (1) the rate at which each cylinder would absorb additional moisture, (2) the total amount of moisture required for complete saturation of each specimen, (3) the compressive strength of each cylinder when saturated, and (4) the amount of vertical deformation of each saturated cylinder when structure-rupture occurs.

The *A* data that follow show the soil moisture contents, numbers of consolidation rammer-blows applied, densities of soil structures, compressive strengths, and the vertical deformations at the times of structure-rupture. These tests were made immediately after the consolidated soil cylinders were removed from the mold.

Data from the *B* experiments show the soil moisture contents and numbers of rammer-blows used in consolidations, and the densities of the test cylinders immediately after they were removed from the mold. Also shown are moisture contents, densities, compressive strengths, and amounts of vertical deformations at the times of structure-ruptures of the differently consolidated cylinders that were slowly wetted to saturation after being removed from the mold. Data on the rates of moisture absorption—increases in percentages by days—are shown graphically.

All test cylinders reported herein were made from one large, well-mixed sample of clay soil, with constants (determined in accordance with Bureau of Public Roads procedures) approximately as follows: liquid limit, 47.7, plastic index, 22.5, lineal shrinkage, 15.7, and optimum moisture, 27.7 percent for maximum density with a total of 75 rammer blows per test cylinder. They were formed in a 4-in. cylindrical mold, 4.59 in.



Cyl. No	Compaction in Rammer Blows	Original Density lb./c.f
1	150	94.4
2	200	93.3
3	225	100.5
4	250	101.9
5	275	100.9
6	350	102.8
7	475	101.9
8	500	100.3

Fig. 2. Relation of rate of absorption and time required for full saturation of several specimens of same soil after being compacted under various rammer blows. These specimen numbers correspond to those in table.

high, having a volume of 1/30 cu. ft. Consolidation was by a 2 in. ram, weighing 5½ lb. and dropped 12 in.

Specimens loaded upon compaction

For the *A* series of tests the approximate amount of wetted soil required for a trimmed test cylinder was computed and placed in the mold in three equal parts, then 30 percent of the total number of rammer blows per cylinder was applied to the bottom third of the soil volume, 34 percent to the middle third, and 36 percent to the top third. When the specified number of blows had been applied, the top of soil was trimmed flush with top of mold. The cylinder was removed from the mold, weighed, and placed in a covered pan in a humidor.

These test cylinders were prepared in four groups, in such manner that the only variable in each group was the number of rammer blows applied to each soil specimen. As soon as from two to four cylinders of a group were molded, they were placed in a standard compression testing machine and slowly loaded until the load indicator stopped rising and started back down, indicating that rupture had occurred. The maximum reading in pounds divided by the cylinder end area in square inches was recorded as rupture-load in pounds per square inch.

Immediately prior to pouring each one-third of the wetted, well mixed soil into the mold, a moisture content sample was taken therefrom; and immediately after each test cylinder was loaded to rupture, another moisture sample was taken from the center of the cylinder, as a check. Both the before and after molding samples were dried to constant weight in an oven at 230 deg. F. Generally, there was very little difference in the two companion samples. Where there was an appreciable difference, the average of the two was recorded as the moisture content at time of structure rupture.

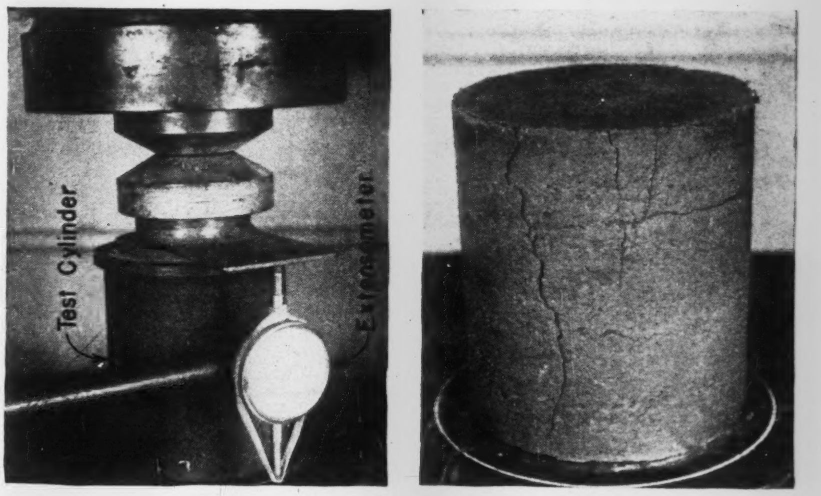


Fig. 3. Arrangement in loading saturated test cylinders to failure, and appearance of a failed specimen.

The density of soil in each test cylinder, in pounds per cubic-foot was determined by dividing the weight of the cylinder when removed from mold, by the percentage of moisture plus 100 and multiplying by 100, in accordance with A.A.S.H.O. "Standard Specifications for Highway Materials and Methods of Sampling and Testing," 1938 edition.

The results of those tests are shown in Fig. 1.

Tests on saturated samples

Eight test cylinders of the same soil were molded with various moisture contents ranging from 19.2 down to 11.7 percent, and to different degrees of compaction. The density of the soil in each cylinder was computed upon removal from the mold, and then each specimen was packed very loosely in sawdust with 75 percent moisture content (75 grams of water to each 100 grams of air-dry sawdust) in a 1 gal. pail, set in a humidor, and allowed to remain there from two to four days. All eight cylinders then were transferred to sawdust packing with moisture content of 100 percent. In four more days they all were transferred to 125 percent moisture content sawdust; and so on, as shown in the graph of Fig. 2, until about the 25th day each of the eight cylinders was transferred to 200 percent (practically saturated) moisture content sawdust. They then were repacked every four or five days in 200-percent moisture content sawdust until about the 70th day when each was transferred to 225 percent (practically dripping) moisture content sawdust. All test cylinders then were repacked every four or five days in

RESULTS OF SOAKING SPECIMENS TO SATURATION, THEN LOADING TO FAILURE

	Condition at start of test			Condition at 63rd day		Saturation		Condition when loaded to failure			
Specimen No.	No. of Rammer Blows	Moisture Percent	Density Lb./c.f.	Density Lb./c.f.	Vol. Incr. Percent	Time Days	Moisture Percent	Wetted Days	Moisture Percent	Load P.s.i.	Vert. def. In.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	150	19.2	94.4	87.9	7.4	52	29.7	84	29.7	15	0.07
2	200	18.6	99.3	92.1	7.9	84	27.2	96	27.6	19	0.07
3	225	19.3	100.5	93.7	7.2	84	26.1	96	27.0	23	0.06
4	250	18.6	101.9	94.2	8.2	85	26.1	97	26.8	23	0.08
5	275	18.7	100.9	93.6	7.8	92	26.3	97	26.9	23	0.08
6	350	17.6	102.8	95.8	7.3	84	24.3	96	25.2	29	0.09
7*	475	13.9	101.9	89.6	13.8	85	29.1	97	30.0	11	0.04
8	500	11.7	100.3	84.1	19.2	71	32.8	86	33.6	5	0.06

* Density 88.0; vol. change 15.9 percent at time this specimen was ruptured.
Note—Specimen numbers correspond to those in the chart Fig. 2.
Moisture contents figures on 100° F oven-dry basis, which are 4 percent lower than the 230° F basis used in the "A" tests.

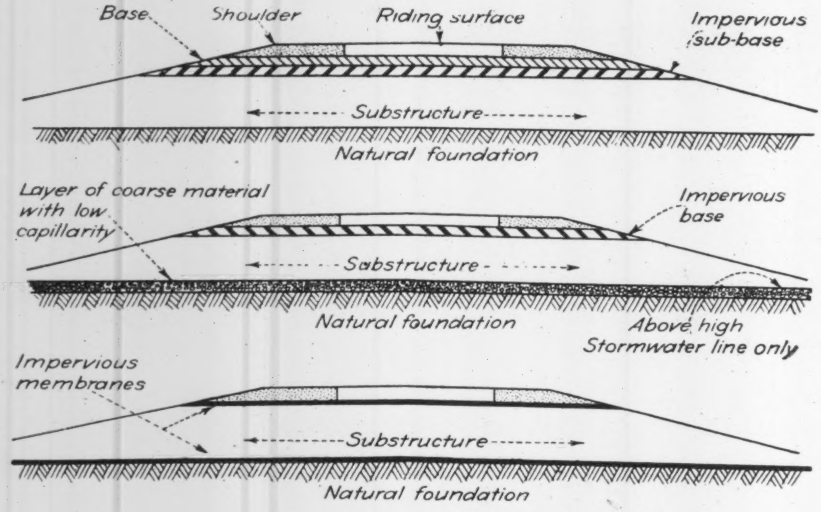


Fig. 4. Three possible methods of keeping water out of highway foundations.

225 percent moisture content sawdust until the cylinders would absorb no more water. After being saturated, each test cylinder was loaded until rupture of its structure occurred, as recorded in the accompanying table and in Fig. 3. Each time a cylinder was transferred from one sawdust packing to another, the cylinder was weighed and its moisture computed, as recorded graphically in Fig. 2. Perhaps these specimens could have been wetted more rapidly without disintegration of the soil structures, but no chances were taken.

On or about the 63rd day after the soil cylinders were molded, it appeared that they had almost reached saturation; hence the volumetric change (increase) was determined by micrometer caliper measurements. The volumetric changes varied from 7.4 to 19.2 percent, as shown in Col. 6 of the table. In order to determine whether there was an appreciable difference between those increases in volumes and the total volumetric changes when saturation was reached, the No. 7 cylinder was remeasured when it became saturated. The volumetric change at that time was 2.1 per cent greater than it was on the 63rd day of wetting.

About the 85th day after molding, the Nos. 1 and 8 test cylinders had reached saturation and were loaded slowly, as illustrated in Fig. 3, until rupture of the structures occurred; and on the 96th day cylinders No. 2 through No. 7 all had reached saturation and were loaded to rupture. The rupture loads are shown in Col. 11 of the Table. Vertical deformations are shown in Col. 12 of this table.

Conclusions from tests

From these data and from those compiled from previous experiments* the following conclusions are drawn:

1. An integral subsoil structure with sufficient compressive strength to carry the maximum loads imposed thereon without failure of the soil, must be created by proper consolidation during construction to obtain satisfactory results from clay soils beneath runway and roadway pavements.

2. The substructure soil must not be subjected to loads that will cause structural failure in the soil.

3. The compaction force represented by 75 rammer blows in the laboratory tests is not enough, in many cases, to create adequate compressive strength in the soil to carry maximum loads without failure, when the moisture content at the time of consolidation is the customary optimum regarded as producing maximum density with that amount of compaction force.

4. When the soil contains that optimum moisture, increasing the compaction in some instances results in an increase in compressive strength.

5. Decreasing the moisture content and increasing the compaction force, within certain limits, results in an increase in the compressive strength of the clay soil structure.

6. Except where the natural moisture in the soil is exceedingly low, addition of water to clay soil before compaction defeats the objective of high compressive strength.

7. Laboratory tests on clay soils containing their natural moisture as excavated from the borrow pit, will indicate the correct compaction required to produce the most efficient compressive strength in the soil in place in the roadway or runway.

8. If compressive strength sufficient to carry the expected traffic loads without failure cannot economically be created in a clay soil, then the pavement should be designed with adequate beam strength to distribute the loads in a manner to prevent rupture of the soil structure, considering the maximum moisture the soil eventually will contain.

9. When an expansive clay soil is properly consolidated, it immediately should be covered in some manner to prevent moisture content fluctuations that might disintegrate the top of the soil structure. Loose soil may be spread over the consolidated soil as a temporary protection, but must be removed before the pavement is laid.

10. If the top of a properly consolidated clay soil should become disturbed or disintegrated before being surfaced, the disintegrated soil must be either reconsolidated or removed.

11. Tests show that under conditions of constant moisture content, no appreciable vertical deformation or settlement occurs if the soil has been properly consolidated, as long as the soil structure is not ruptured.

12. Where the economical degree of consolidation does not give the soil compressive strength sufficient to carry maximum loads without failure, the pavement should be so designed that it will never deflect enough to cause the soil to rupture.

13. Density of a consolidated clay soil, as usually measured in pounds per cubic foot, is not always a criterion of its compressive strength.

14. Even though consolidated to a high compressive strength, a clay soil under subsequent exposure to free water for a great length of time will increase both in moisture con-

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*See *Engineering News-Record*, June 16, 1938, p. 839; June 30, 1938, p. 902. Highway Research Board *Proceedings*, 1937, p. 494; 1938, p. 339; 1941, p. 466; 1942, p. 468; and 1943, p. 529, Am. Soc. Civil Engineers *Proceedings*, Feb., 1940, p. 193. Texas Engineering Experiment Station *Bulletins* Nos. 67 through 71-A, Texas A. & M. College, College Station, Texas.

tent and in volume, the amounts depending upon the type of soil and amount of water absorbed.

15. The absorption of additional water by a consolidated clay soil may be too slow to cause rupture, but the increase in moisture content will result in a corresponding decrease in compressive strength, as much as 75 percent in some instances.

16. As long as a densely consolidated soil is not ruptured, its affinity for water is not great. This phenomenon should be considered in the design of roadways and runways.

Designing to keep out water

From the above conclusions it is apparent that keeping water out of a consolidated clay soil is most important. The three principal sources of water detrimental to compacted soil are rain, seepage and high groundwater level. Rain and seep water usually reach the soil structure by gravity, while groundwater works into the compacted course by capillarity. There are several preventative measures that can be taken in design and construction of roadways and runways to prevent water from reaching the consolidated soil structure.

To keep water from a high groundwater level from working upwards into the consolidated soil substructure by capillary action, efficient subdrains can be installed to lower the water-table. Another possibility is the building of a cutoff between natural and consolidated soil, either by means of a waterproof membrane on top of the natural soil, or by the insertion of a layer of gravel or other coarse material that will break up the capillary action.

Seep water can be intercepted by proper surface and subsurface drains. To keep out rainwater, in some instances it will pay to completely cover the top of the consolidated soil with an impervious membrane.

The treatment will depend upon conditions. The most economical and efficient procedure in one case may not be proper in another situation. Where the groundwater level is far below the consolidated soil, protection from capillary water may not be needed. Likewise, subsurface intercepting drains may not be necessary where there will never be any seep water. Yet, it must be remembered that investigations made during a dry season might not indicate conditions to be found during a wet season, particularly as to groundwater level and possible appearance of seep water. Protective measures should be taken in all cases where there is any possibility of seepage or capillary water getting into the consolidated clay soil. After the compacted soil has been ruptured by admission of excess water, repairs are always expensive.

In the design of clay soil substructures, coarse-grained material should never be placed on, or flanked by, impervious material in such manner that water will be entrapped. (See *ENR* June 16, 1938, p. 842.)

As stated before, consolidated clay soils vary in volume with changes in moisture content. Thus, from the standpoint of maintaining a smooth riding surface on the roadway, control of water getting into the subgrade is important.

These studies and tests indicate the same principles of consolidation might well be used to advantage in designing other types of foundations, such as those for bridges and buildings, where high compressive strength is required in the subsoil.

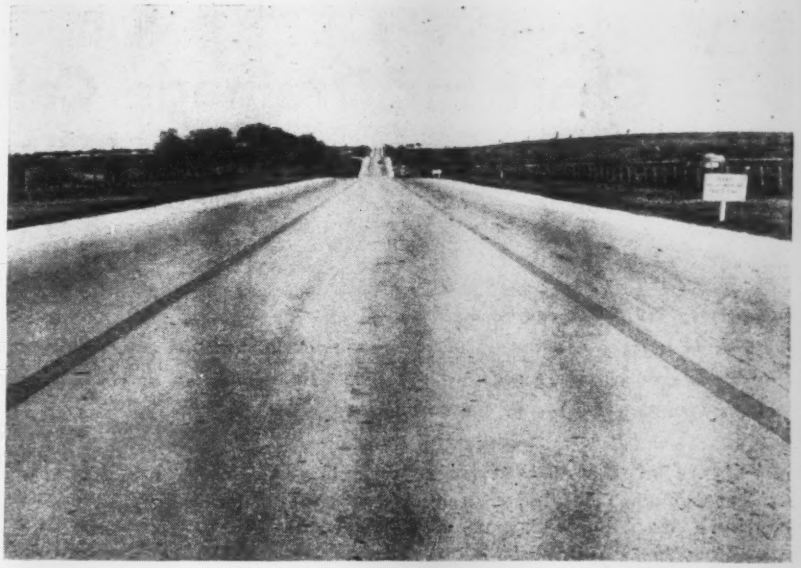


Fig. 5. The fine condition of this pavement, after ten years of service, including much war-time traffic is due in part to the care used in preparing its base.

Hydroelectric Resources of Americas

Out of potential hydroelectric resources of 45,000,000 hp., the South American countries have developed less than 1,000,000 hp., it is pointed out in a report on Brazilian power resources by the Brazilian Commission of Inter-American Development, submitted to the Inter-American Development Commission, Washington, D. C.

With a 20,000,000 hp. potential, Brazil has developed about 700,000 hp., the report notes in an account of Brazil's undeveloped power resources and Brazilian plans for developing these resources.

Comparing hydroelectric resources of the Americas, the report sets forth the following table:

HYDROELECTRIC RESOURCES OF AMERICAS

Nations	Existing Potential (in hp.)	Utilized Potential (in hp.)
Central America	5,000,000	105,200
Argentina	5,000,000	35,000
Bolivia	2,500,000	13,500
Brazil	20,000,000	700,000
Canada	18,000,000	7,547,000
Chile	2,500,000	114,000
Colombia	4,000,000	25,000
Ecuador	1,000,000	6,400
Mexico	6,000,000	450,000
Paraguay	2,000,000	300
Peru	4,500,000	55,000
Uruguay	300,000	——
Venezuela	3,000,000	15,000
West Indies	150,000	40,000
United States	42,000,000	16,075,000
Total	115,950,000	25,181,400

Chart for Drainage Calculations

Dennis E. Donovan
Professional Engineer, Oklahoma City, Okla

***Contents in Brief**—A new formula will aid the designer of small drainage structures in quickly and accurately determining the time of concentration necessary in calculating storm flows. A chart is presented to aid in solving problems involving the use of the formula.*

CALCULATION of the size of adequate but economical drainage structures, such as culverts and small bridges, depends entirely on determination of the quantity of storm water to be handled. In estimating this flow much depends on the judgment of the designer, for, although available information and formulas serve to support his judgment, values must be assumed for several of the factors involved.

Among the more important of these factors is the time of concentration t of the storm flow, since the intensity of precipitation i is a function of t. Of particular interest, therefore, is a new formula derived below which gives quickly and accurately the time of concentration.

Where much of the flow is over fields, there being no established water courses such as ditches or sewers, Manning's formula

$$V = K\,S^{1/2}\,R^{2/3}$$

may be adapted to give the minimum time of concentration. In calculating the capacity of drainage structures, it should be assumed that rain has been falling for some time, that the surfaces are wet with all depressions filled, and that pervious soil, evaporation, etc., will retain a constant amount of moisture per hour. The amount retained will vary with the foliage, perviousness of the soil, temperature, etc.

Until this requirement is satisfied, there will be no runoff. Thereafter, runoff will be in proportion to the intensity of precipitation, less this retained amount. If a is the intensity required to establish runoff, the intensity that should be used in design is $r = i - a$. The rational formula may then be revised to read $Q = rA$.

Since the quantity of water flowing is the product of the velocity times the cross-sectional area of the stream, and the cross-sectional area of the stream is the product of the hydraulic radius times the wetted perimeter, $Q = RwV$. Combining this equation with the revised rational formula to eliminate Q, $R = \frac{rA}{wV}$. If this value of R is substituted in Manning's formula,

$$V = KS^{1/2}\left(\frac{rA}{wV}\right)^{2/3},$$

which reduces to

$$V = K^{0.6}S^{0.3}\left(\frac{rA}{w}\right)^{0.4}.$$

If V is the velocity at any point and v is the average velocity up to that point:

$$v = \sum_{B_1}^{B_2}\frac{V(dA)}{B_2 - B_1}$$

$$= K^{0.6}S^{0.3}\left(\frac{r}{w}\right)^{0.4}\sum_{B_1}^{B_2}\frac{A^{0.4}(dA)}{B_2 - B_1}$$

$$= K^{0.6}S^{0.3}\left(\frac{r}{w}\right)^{0.4}\frac{B_2^{1.4} - B_1^{1.4}}{1.4\,(B_2 - B_1)}$$

in which B_2 is the area contributing to flow at the lower end of the section under consideration, and B_1 is the area contributing at the upper end. Substituting

$$B^{0.4} = \frac{B_2^{1.4} - B_1^{1.4}}{(B_2 - B_1)\,w^{0.4}}$$

and Manning's value of

$$1.486/n \text{ for } K;$$

$$v = \frac{S^{0.3}r^{0.4}B^{0.4}}{1.1n^{0.6}}.$$

Since $t = d/v$,

$$t = 1.1\,\frac{n^{0.6}d}{S^{0.3}r^{0.4}B^{0.4}}.$$

If t is expressed in min., d in ft., S in ft. per thousand, r in in. per hr., B in acres per ft., and w in ft.;

$$t = 0.146\,\frac{n^{0.6}d}{S^{0.3}r^{0.4}B^{0.4}}.$$

If the value of B is taken as

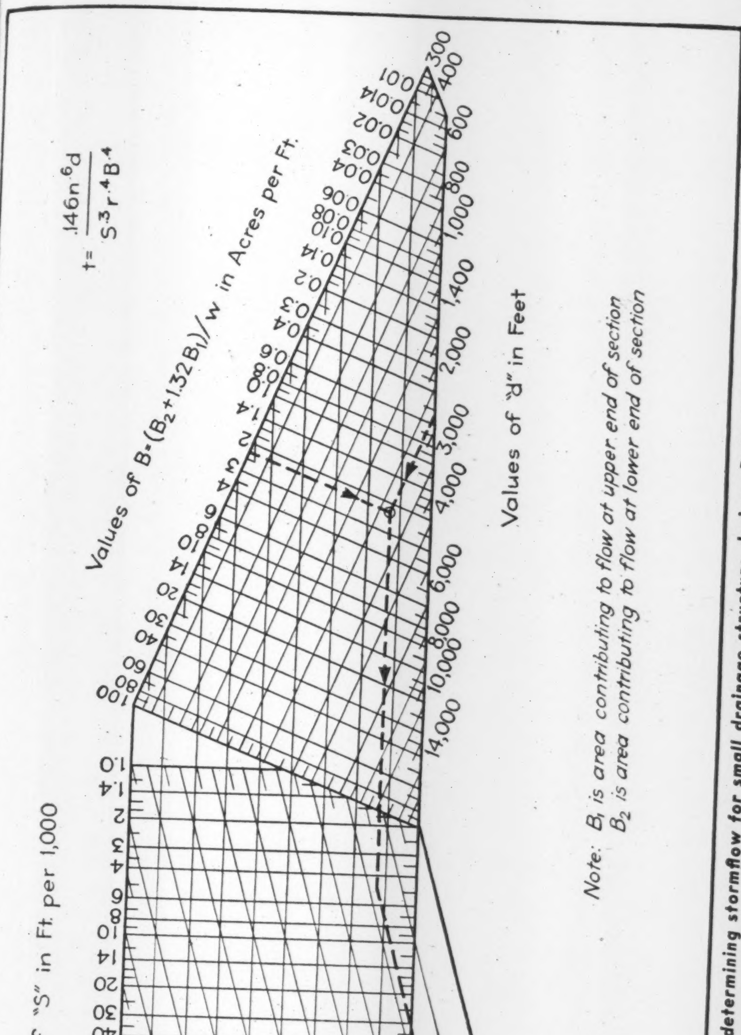
$$\frac{B_2 + 1.32\,B_1}{w}$$

the resultant error in t will be less than one percent. In the case where the section under consideration is at the most remote part of the watershed, $B_1 = 0$ and $B = B_2/w$. Values of n are the same as those for use with Kutter's formula, and can be found, together with Meyer's formulas for intensity of rainfall, in Metcalf and Eddy's *American Sewerage Practice,* (McGraw-Hill Book Co.).

The accompanying diagram simplifies solution of the formula. Dotted lines on the diagram show the method of use for one problem.

The various factors which must be determined frequently vary over the watershed under consideration, and average values must be assumed. The assumed averages can sometimes be made more accurate by dividing the watershed into sections which have fairly even slopes, uniform retention factors, uniformly increasing contributing areas, constant stream widths, etc. The times of flow for the various sections can then be read from the diagram and added together to get the time of concentration. In any case the solution is by trial and error; a trial value must be assumed for i and the solution for each section adjusted until the values of r correspond to the value of i derived from the time of concentration.

The principal difficulties in the use of the formula are in estimating the coefficient of friction n and the wetted perimeter w, which for shallow depths of flow may be taken as the average width of the stream. Fortunately, the error in t will vary



Note: B_1 is area contributing to flow at upper end of section
B_2 is area contributing to flow at lower end of section

Chart based on new formula gives time of concentration, necessary in determining stormflow for small drainage structure design. Dotted lines show solution of typical problem.

about as the square root of the error in estimating these two values, and the effect on *i* will be still less. It is worthy of note that the distance *d* has more influence on the final result than any other factor, including the area. Considerable research will be necessary to establish reliable values for *a*, which should be kept very small until such values have been established.

The principal limitation on use of the formula seems to be that the contributing area must be small enough that the intensity and distribution of rainfall may be assumed to be comparatively uniform over the entire area for a period as long as the time of concentration.

The theory that the hydraulic radius is a determining factor and that Manning's formula will be applicable under the conditions, may be open to question. However applicability depends largely on the assumed values for *n*, which can be more accurately determined by experiments based on this formula. The hydraulic radius has been replaced by *w* the wetted perimeter, of which it is really a function, and its influence depends largely on a correct evaluation of *w*.

Five-year Road Program Proposed in Venezuela

A five-year Venezuelan road construction program calling for the expenditure of $80,550,000 was among the many highway projects recently discussed by the Second Congress of Venezuelan engineers.

The program as outlined by the engineers, according to a United States Department of Commerce report, proposes construction of approximately 460 miles of road during each of the five years. The mileage will be chiefly extensions or improvements of the present national highway, which, according to the most recent report on the subject, now totals 5,164 miles.

In addition to the project under consideration, work is now under way on the construction of an all-weather road from Puerto de la Cruz to El Sombrero. This road is being built by oil companies having concessions in that area and will cost the companies about $7,000,000.

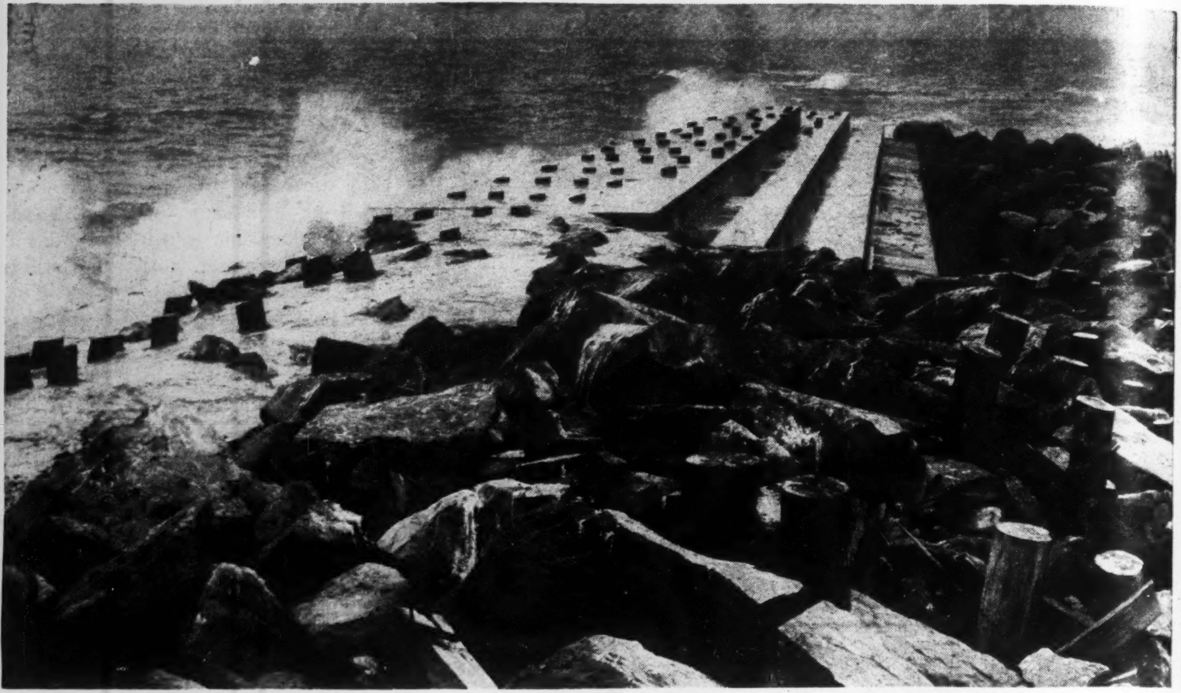


Fig. 1. The concrete terminal at the sea end 3.3 mi. offshore. Exposed side is at the left.

A Jetty Built to Resist Heavy Seas

***Contents in Brief**—Outer portions of the Columbia River jetty have been rebuilt with a concrete terminal and toe walls planned for maximum resistance to high, storm-driven waves. Design and methods of construction are based on long experience with damage from extremely severe wave action*

RECENT RECONSTRUCTION and extension of the south jetty at the mouth of the Columbia River bring out new ideas in protective work of this sort. Based on many years of experience in maintaining this structure, effective methods were used for sheltering the work from waves while concrete was poured in a heavy monolithic terminal from which concrete toe walls extend. Concrete was generously used for a matrix to bind together and anchor surface rock, and baffles were set near the inshore end of the exposed toe wall to protect adjoining rubble from directed wave action.

This jetty lies in what is said to be one of the most exposed locations on the Pacific Coast. The continental shelf is relatively narrow and winter storms, with centers generally passing inland on the Washington coast, cause very heavy seas which run unbroken through the deep water and strike the jetty with very destructive effect. The original enrockment was carried out to a point nearly 4 mi. off the present shore line in water depths of 30 to 60 ft.

Under these conditions it has been found that to withstand winter storms a jetty must have a heavy section with wide base, and be high enough to prevent ordinary winter seas from passing over the top in force. The individual pieces of stone used in the rubble section must be as large and heavy as it is possible to secure and handle, so that after initial settlement further movement will be reduced to a minimum.

The rubble jetties considered best are those that have been in place for 10 to 20 yr. and have thoroughly settled and been flattened by wave action, and have then been raised to full height with a superstructure of rubble or concrete, or a combination of these.

The original Columbia jetty completed in 1913, nearly 7 mi. long, contained some 6 million tons of stone. Rehabilitation in 1932 required some 2½ million tons more, thus bringing the total to 6½ million tons. The jetty started at Fort Adams (Fort Stevens), which is now inshore from the present shore line because Clatsop Spit has built up across the jetty so that the active part of the jetty as rehabilitated now extends out only about 3.3 mi. from the shore line.

After some 20 yr. of battering by storms the seaward part of the structure was beaten down to approximately low tide level with a top width of about 200 ft. It was then decided to rehabilitate the jetty by placing a heavy rubble superstructure to El. 26 ft. above low water. This superstructure, completed in 1935, was ound to be raveling back from the uter end at the rate of about 300 ft. er annum. This raveling extended own only to the old base stone, howver, and did not greatly affect the riginal portion of the structure below w tide level. An asphalt binder was ied in 1936 to stop end raveling, ut without success (see *ENR* Aug. 2, 1937, vol. p. 273).

The purpose of the recent extension d addition to the superstructure was replace lost rock and to prevent rther raveling. An important feare of the new superstructure is the ncrete terminal at the outer end signed for maximum durability unr extreme exposure.

In carrying out this additional work e first requirement was for a railad track on trestles supported on e old enrockment at low water level. he piles for these trestles had to be driven" in the old enrockment. The iving consisted of little more than dging the piles in between the cks. Crevices were such that the les could be put down perhaps 3 more or less. The trestle was made gid enough for service by bent bracg, by the deck structure and by adtional rock dumped around piles alady in place. It was inadvisable use longitudinal bracing because insweep of heavy seas is roughly right angles to the jetty center line. Such trestles are not expected to nd long on the outer end of this ty except during the calms of the summer season. The cutoff is at El. 26 and hence total service length of piles is only about 29 ft. The custom has been to lay track on not more than ten or fifteen such bents before dumping rock around the piles for additional support.

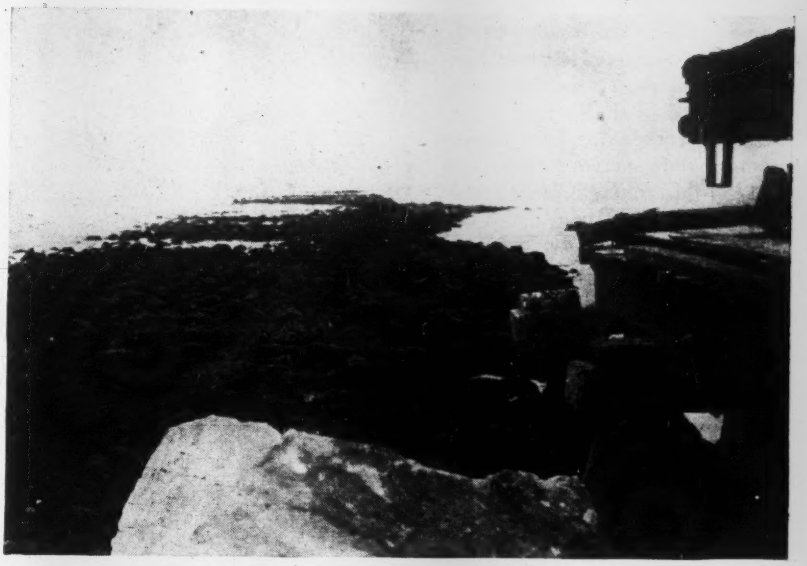
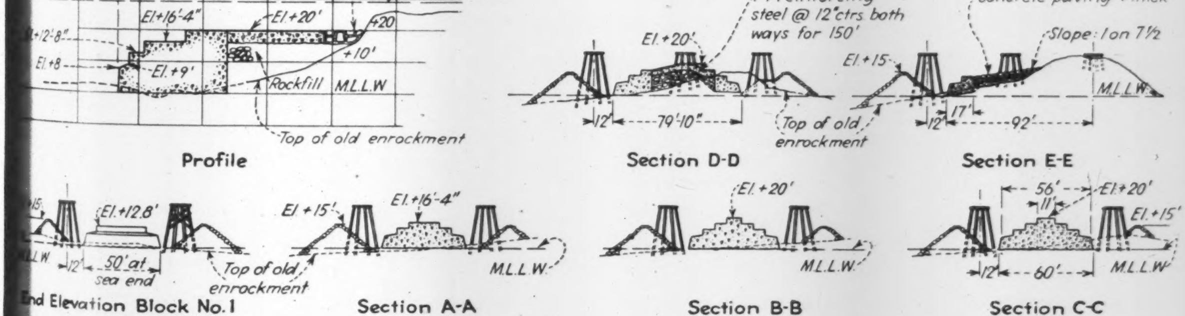


Fig. 2. Old enrockment at low tide before adding superstructure. This view looks seaward toward the mile-distant site of the new terminal.

The trestles from which concrete in the terminal block was placed, however, could not be given rock support and had to depend on the rubble mound "cofferdams" for protection from wave action. The use of these is made apparent by the accompanying drawing. Beyond the concrete terminal the trestles were drawn nearly together and the cofferdam closed at the sea end. Piles in trestles that had to be built through the terminal were left in place and concrete was poured around them.

Concreting operations farther inshore, in the toe wall, and paving were similarly carried on from the trestles. Prior to pouring the pavement, it was desirable to plug any large holes between rocks with blocking and burlap to prevent too great



Plan

Profile

Section D-D

Section E-E

nd Elevation Block No. 1

Section A-A

Section B-B

Section C-C

Width 60'
A
B
C
D
E
Toe wall
Approx toe of jetty rock at M.L.L.W.
34'-5"
Slab
Terminal block No. 1
72'
Paving
92'
170'
150'
Toe wall
4 baffles @ 50'
Chain net
3'x6' conc. anchor
1,132'
Outer end of concrete
4' paving +20'
+30
Base of trestle rails El. +29'
El. +16'-4"
El. +20'
+20
El. +12'-8"
El. +8
El. +9'
+10'
Rockfill
M.L.L.W.
Top of old enrockment
1" reinforcing steel @ 12" ctrs both ways for 150'
El. +20'
12'
79'-10"
Top of old enrockment
Concrete paving 4' thick
Slope: 1 on 7½
El. +15
M.L.L.W.
17'
12'
92'
15
El. +12.8'
M.L.L.W.
12'
50' at sea end
Top of old enrockment
El. +15'
El. +16'-4"
M.L.L.W.
El. +20'
M.L.L.W.
56'
11'
El. +20'
El. +15'
12'
60'
M.L.L.W.

3. Plan, profile and sections showing shape and relation of parts of the new superstructure. Rubble mounds serve as fferdams" to protect piling of the construction trestle and the newly placed concrete.

a loss of concrete. The gravel aggregate served to plug the smaller voids. After stopping concrete loss from flow into the rock voids, a good tight paving was secured on the surface of the enrockment, embedding the large fragments in the concrete matrix. The thickness of this concrete paving varied; 4 ft. or more was considered the minimum along the exposed side of the jetty. No chinking was required in the old enrockment under base of main terminal blocks and wall.

The terminal or monolithic concrete mass at the outer end extends entirely across the enrockment and has a total length of 320 ft. At the sea end the width is 50 ft. and this widens as it extends shoreward. Along the south side of the jetty, which is the face exposed to the waves driving in from the ocean, the concrete toe wall is continued landward some 1,100 ft. This is of considerably lighter construction than the heavy sections used in the concrete monolith at the outer end, but it is backed up with stone and the surface paving mentioned in the foregoing.

A feature of the toe wall toward the inshore end is the use of baffles put in to break up and dissipate the energy of heavy waves before they reach the rubble part of the jetty. The seas strike the toe wall at an angle and it was believed that if unobstructed they would run at high velocity along the toe and the step that lies just above it to strike the rubble beyond with destructive effect.

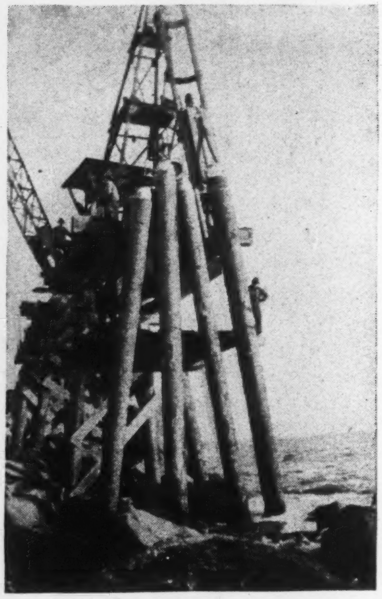


Fig. 4. Piledriving in large rock fragments is little more than a "wedging in" process. More rock is later dumped around the bents to steady them.

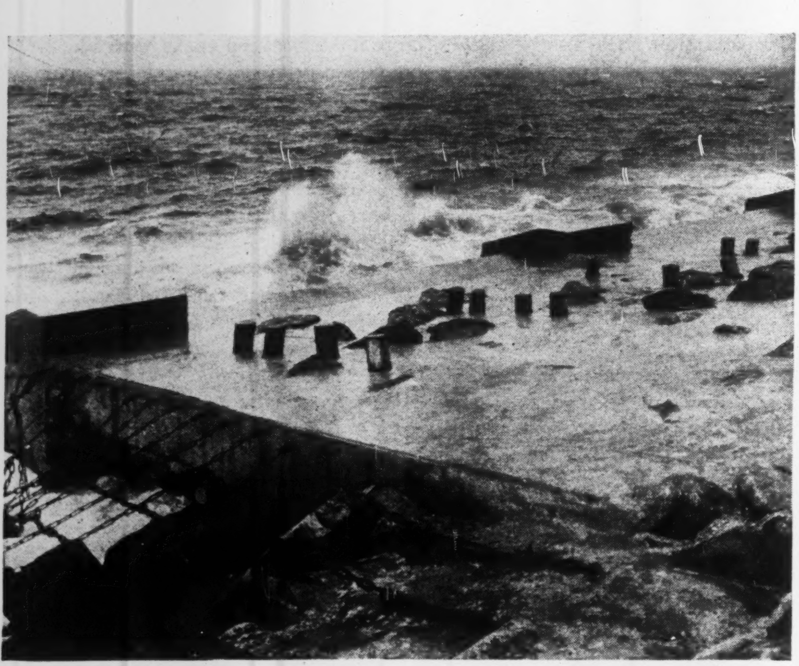


Fig. 5. Baffles in the toe walls are to break up cumulative force of waves that sweep in diagonally. Note chain net tying concrete and rubble together.

The baffles are to break up this running of the waves and to prevent them from using the concrete toe and step as training walls that might give the waves something of a cumulative effect while directing them against the rubble. These baffles are believed to have functioned in the manner intended, although it is not possible to get near enough during a heavy storm to observe or photograph the action.

Chain net ties concrete and rubble

Another novelty in design is the use of a chain net for a distance of 110 ft. along the exposed side and inshore from the end of the concrete toe wall. This was an experimental endeavor to make a flexible connection between the concrete toe and the rubble construction near the inshore end of the concrete. The plan was to lay a grid of heavy corrosion-resisting chains on 3-ft. centers each way, over a 66x111-ft. area of heavy rubble. At the ocean end the grid or net was secured to eyebolts in concrete of the toe or the concrete paving behind it. On the inshore end a 3x6x66-ft. concrete anchorage was poured expressly for the chain net. On the two sides expansion eyebolts, sunk 2½ ft. into large stone, served as anchorages.

However, because it was placed under unfavorable weather conditions at the end of the season, difficulties prevented completion of this netted section according to design. The contractor had lost a crane just before the attempt to place the heavy rubble began and it was possible for men to work on the rock only during very short periods at low tide. Under these conditions the stone placed in the section was smaller than was intended. was not packed in as firmly as it should have been before tightening the chains and consequently rock losses were sustained. Because this part of the work could not be satisfactorily carried out the damage it later sustained is not regarded as proving the idea to be without merit.

Those in charge

Construction of the concrete terminal and incidental work was done by Columbia Contract Co., of Portland, in 1941. Colonel (now Major General) Cecil R. Moore was then district engineer. Colonel Ralph A. Tudor is the present district engineer at Portland, and R. E. Hickson, principal engineer, has been in charge of river and harbor improvements for many years.

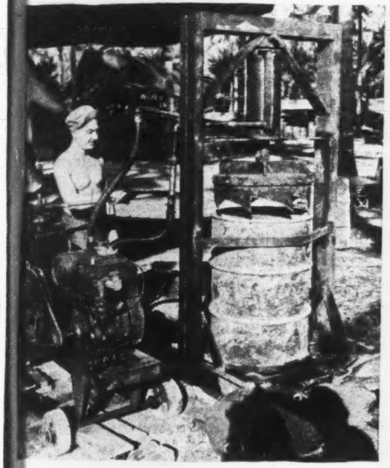
From Field and Office

WORKING PROBLEMS AND TIME-SAVING METHODS FOR ENGINEERS AND CONTRACTORS

Job-Made Drum Opener

To remove the heads from empty oil drums, which are put to a variety of uses in the war theaters, including culverts, chimneys, and forms for concrete work, the hydraulic opener shown below was constructed by the Navy's Seabees. Two heads per minute can be removed with this equipment.

The cylinder, piston and cutter are of welded boiler plate and are mounted in a structural steel frame. The cutter edges were built up with tool-steel welding rod to make them durable. Equipment used to operate the device includes an oil pump and control valve from a bulldozer and a 1½-hp. air-cooled gasoline engine.



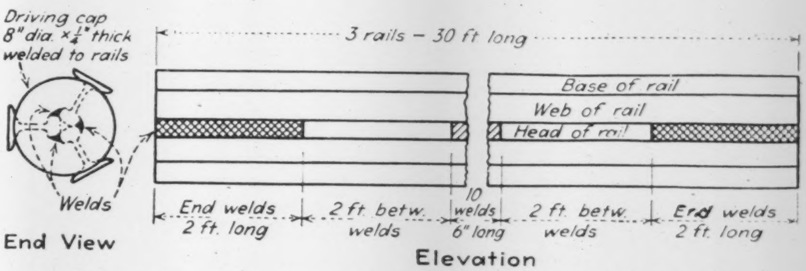
Oil drum heads are removed at the rate of two a minute with this cutter.

Seabee officers recommend construction of an opener of this type only where a large number of heads must be removed.

The above description is an abstract of an item that appeared in *Construction Battalion Activities* published by the U. S. Navy.

Welded Rails Make Rigid Piles

The need for rigid bearing piles to be driven under bridge piers and the availability of old rails were a combination of circumstances that the Southern Pacific Co. has utilized to good advantage in making up piles of the type shown in the accompanying sketch. By making continuous welds at either end 2 ft. long, on either 50- or 62-lb. rails, it has been found sufficient to put intermediate welds 2 ft. apart. Even in hard driving this pile goes down without any tendency of the rails to separate and many of them are now giving satisfactory service under several of the company's bridge piers.



Weld-location sketch for a rail grouping that drives well as a pile.

Oregon Bridge Enclosed During Curing Period

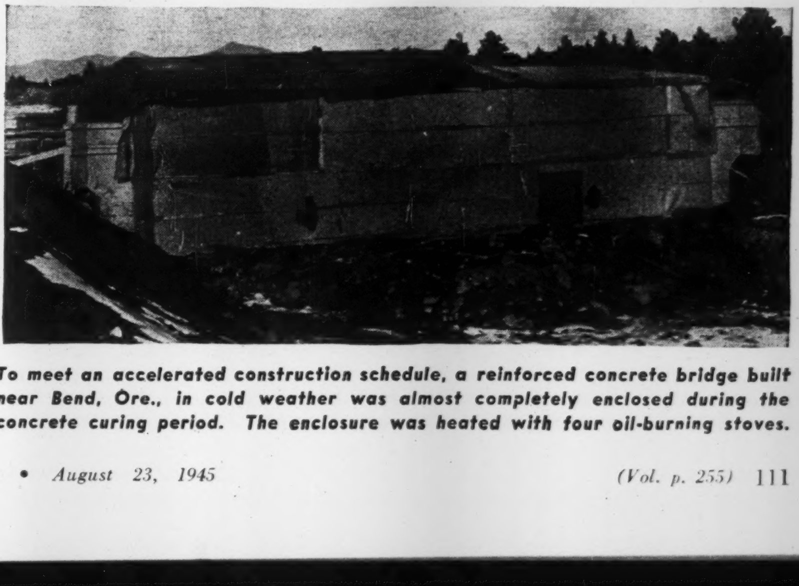
In carrying on an accelerated construction program in connection with the Deschutes project of the Bureau of Reclamation, a reinforced-concrete bridge built in cold weather was protected during the curing period by enclosing the structure as shown in the accompanying illustration. By this method the project was completed on schedule at little additional cost.

The structure is a slab-and-beam type with an integral beam-and-floor deck, which provides a 24-ft. clear roadway. The deck is supported on reinforced-concrete abutments and center pier. The total span is 49 ft.

The enclosure consisted of asphalt-impregnated paper sheathing, supported on a light timber framework; the joints being sealed with the same material. Lowest temperature during the curing period was 20 deg. During this time the enclosed space was heated by four oil-burning stoves.

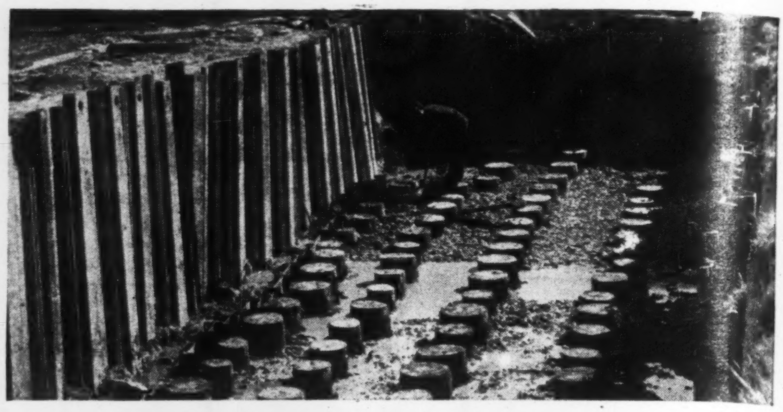
Constructed at a cost of $400, the greater part of the enclosure was salvaged for use on other structures.

Known as the Ochoco Bridge, the structure was built by the McLaughlin Construction Co., Missoula, Mont., with J. A. Webb, and R. L. Anderson



To meet an accelerated construction schedule, a reinforced concrete bridge built near Bend, Ore., in cold weather was almost completely enclosed during the concrete curing period. The enclosure was heated with four oil-burning stoves.

local representatives. C H Spencer, *construction engineer, Bureau of Reclamation, Bend, Ore.*



LOSS OF GROUND PREVENTED BY PILE CUTOFF WALL

To prevent loss of ground from deeper excavation for utility lines, which may later be laid along the streets, steel piles are used to form a permanent cutoff wall along the road side of abutments for an overpass. Protection against loss of ground is most important where the support for the abutment is merely a spread footing but the same plan was used here for a pile supported foundation. Both H-piles and sheet piles are used for this protection; in the picture shown the H-piles are depended on to add to the support given by the timber pile foundation. The work pictured is on a cutoff around the city of Montreal just being completed by the Canadian National Railway. Design of the structure was directed by C. P. Disney, bridge engineer of the railway's central region. Construction of the bridge and roadway by C. A. Pitts, Ltd., of Toronto, was supervised by N. S. Bateman.

Job-Made Spreader Used On Pacific Paving Work

A mechanical spreader of original design and constructed of salvaged materials is being used effectively by a battalion of Seabees on a Pacific island to rapidly spread sand, fine coral, pea gravel, or stone chips over the seal coat of bituminous pavements. The equipment, which is illustrated by the accompanying photographs, has a capacity of 15 cu. ft. It is 8 ft. 6 in. long, 3 ft. 6 in. wide and 2 ft. 8 in. high.

To permit the spreader to be pushed by a truck loaded with the material to be spread, a $\frac{3}{4}$-in. dia. steel U-bar, welded to the rear of the truck frame, was designed to engage in the upstanding leg of a short horizontal angle placed near the top of the spreader. To make this connection, the front of the spreader is tilted down by raising the handles on the rear side, the spreader pushed into position under the truck, and then the front of the spreader permitted to come up to its normal position. The spreader is made stable by a single adjustable caster located in the front of the machine.

As the spreader is pushed along by the truck, usually at a speed of about 5 mi. per hr., the material is forced through the bottom of the hopper by a horizontal revolving agitator made of 4-in. iron pipe with four $\frac{1}{2}$-in. dia. steel rods welded spirally around the pipe for its entire length. One end of the agitator shaft is equipped with a 4-in. sprocket driven by a roller chain of $\frac{1}{4}$-in. pitch from a similar sprocket mounted on an extension of the main axle. A simple clutch mechanism, operated by a handle at the side of the machine, controls the rotation. A sheet steel flap arrangement, controlled through a lever at the side, regulates the flow of material from the hopper; the opening at the bottom of the hopper may be maintained at any one of a wide range of widths by locking this lever in the notches of its guide collar.

All plate angle work on the machine is of welded construction. The chassis consists of 3 x 3 x $\frac{5}{16}$-in. angles; the horizontal wheel supports and the uprights supporting the hopper are $2\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{1}{4}$-in. angles, and the horizontal hopper stiffener angles are 2 x $1\frac{1}{2}$ x $\frac{3}{16}$ in. The hopper is made of $\frac{1}{8}$-in. black sheet iron. The road drag is a 12-in. wide piece of heavy-duty conveyor belting.

The above description is an abstract of an item that appeared in *Construction Battalion Activities* published by the U. S. Navy.

Made of salvaged materials, an all-welded spreader used by a battalion of Seabees permits rapid distribution of a wide variety of materials. Rear of spreader or that placed nearest truck is shown by left photograph, which also shows levers for controlling opening in bottom of box and clutch of agitator shaft, while right picture illustrates use of machine.

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A LAZY OIL that only lubricates

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4. Is non-corrosive to alloy bearings. Protects all lubricated engine parts against corrosion.

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SHELL

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

HIGHWAY PAVING, INDIANA

OWNER: State Highway Comn. of Indiana, Indianapolis; C. E. Vogelsang, engr.

PROJECT: Reinforced concrete pavement and resurfacing 5.617 miles of State Highway No. 24 in Allen County, Ind., from New Haven in a northeasterly direction.

CONDITIONS: Contractor to furnish all materials and complete work in six months. Highway transportation facilities available to site of work. Minimum wage rates specified are: skilled labor, $1.00 per hour; semi-skilled, 75c.; and common labor, 65c.

BIDS: Three bids were received June 19, 1945, ranging from the contract low of $364,861 to $399,669. Engineer's estimate, $379,910.

LIST OF BIDDERS:

1. Moellering Constr. Co., Fort Wayne, Ind. (contract)	$364,861
2. Acme Construction Co., Inc., Fort Wayne, Ind.	369,677
3. Rieth-Riley Constr. Co., Goshen, Ind.	399,669

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Excavation, common	27,794 c. y.	$0.50	$0.40	$0.60
2. Excavation, waterway	280 c. y.	1.00	1.00	.60
3. Excavation, wet	1.071 c. y.	5.75	6.00	6.00
4. Special borrow	22.591 c. y.	.52	.55	.80
5. Grade B. special borrow	2,307 c. y.	1.65	1.50	2.00
6. Overhaul	1,931 c. y.	.07	.10	.10
7. Pavement removal	23,368 s. y.	.48	.50	.50
8. Salvaged pavement removal	11,684 s. y.	.48	.50	.50
9. Breaking concrete pavement	700 s. y.	.25	.25	.25
10. Finishing shoulders and ditches	30,645 l. f.	.31	.20	.30
11. 18-in. rein. concrete pipe	16 l. f.	3.50	3.50	3.50
12. 15-in. rein. conc., vitr. clay, cast iron or conc. pipe	348 l. f.	2.15	2.00	2.50
13. 18-in. as above	66 l. f.	2.50	2.50	3.00
14. 36-in. pipe relaid	75 l. f.	3.00	3.00	3.00
15. 6-in. vitr. clay sewer or cem. conc. sewer pipe	8 l. f.	1.00	1.00	1.00
16. Drain tile, 6-in., vit. clay or conc	540 l. f.	.55	.55	1.00
17. Vit. clay, cem. conc., or ext. quality drain tile for subsurf. drnge., 6-in.	17,014 l. f.	.55	.55	.60
18. Vit. clay or cem. conc. sewer pipe for subsurface drainage, 6-in.	348 l. f.	1.00	1.00	1.00
19. Aggregate for subsurface drainage (No. 7)	477 c. y.	3.00	3.25	4.00
20. Natural sand backfill for subsurface drainage (No. 14)	934 c. y.	2.50	2.50	2.50
21. Remove exist. struct., Sta. 6 + 15	Lump Sum	1,000.00	800.00	1,000.00
22. Remove exist. struct., Sta. 214 + 25.	Lump Sum	800.00	1,000.00	1,000.00
23. Conc. for struct., spec. Cl. D	8.1 c. y.	42.00	40.00	50.00
24. Conc. for struct., Class D	30.6 c. y.	40.00	40.00	50.00
25. Conc. for struct. No. 11 and No. 20, Cl. D	150.2 c. y.	36.00	37.50	40.00
26. Conc. for structs. No. 11 and 20, Class E in footings	364.6 c. y.	32.00	30.00	32.00
27. Conc. for structs. No. 11 and 20, Class E above footing	244.2 c. y.	36.00	35.00	40.00
28. Furnish equipment for driving piles	Lump Sum	200.00	200.00	500.00
29. Timber piles furnished	3,360 l. f.	.38	.50	.60
30. Timber piles driven	2.690 l. f.	.47	.50	.60
31. Rein. steel for structures	56,658 lb.	.08	.08	.08
32. Reconstructed manhole	2.5 l. f.	25.00	10.00	10.00
33. Castings adjusted to grade	1 ea.	15.00	15.00	10.00
34. Catch basin, Type C-5	1 ea.	80.00	125.00	100.00
35. Special inlets	1 ea.	150.00	150.00	150.00
36. Reinforced concrete pavement	44,402 s. y.	2.60	2.55	2.70
37. Reinforced concrete resurface	31,026 s. y.	2.25	2.40	2.50
38. Concrete over-run	697 c. y.	12.00	13.50	12.50
39. Spec. rein. steel for rein. concrete resurface	29,566 lb.	.08	.10	.08
40. Reinforcing steel for pavement	1,229 lb.	.08	.10	.08
41. 1-in. fiber expansion joint	139 l. f.	.75	.60	1.00
42. Contraction joints for rein. concrete pavement	9,991 l. f.	.52	.65	.50
43. Contraction joints for rein. concrete resurface	6,981 l. f.	.52	.65	.50
44. Reconstructed concrete base	116.7 c. y.	27.00	27.00	40.00
45. Compacted aggregate surface	800 ton	4.00	2.50	4.00
46. Bituminous stabilized mixture, type A.	1,123.3 ton	6.50	7.00	7.00
47. As above, type B	1,078.9 ton	6.25	6.75	7.00
48. Subgrade fine aggregate	252 ton	3.50	4.25	4.00
49. Subgrade treatment material	10,390 c. y.	1.80	2.25	2.00
50. 6-in. traffic lane stripe	5.655 mi.	300.00	300.00	500.00
51. Monument, type D	1 ea.	20.00	20.00	25.00
52. Remove flex. steel plate guard rail	224 l. f.	.50	.50	1.00
53. Reset. flex. steel plate guard rail	872 l. f.	1.00	1.00	2.00
54. Guide posts, Type A	28 ea.	3.20	2.00	3.00
55. Guide posts, Type B	50 ea.	3.00	2.00	3.00
56. Barricades, Type A	2 ea.	60.00	40.00	50.00
57. Barricades, Type B	9 ea.	60.00	40.00	50.00
58. X-10-R signs	2 ea.	65.00	30.00	50.00
59. X-13 signs	19 ea.	48.00	25.00	50.00
60. Prewarning signs	12 ea.	75.00	40.00	50.00
61. Bench mark post	1 ea.	22.50	20.00	25.00

HIGHWAY RESURFACING, OHIO

OWNER: Ohio Dept. of Highways, Columbus.

PROJECT: Asphaltic concrete resurfacing 6.843 miles of Section Troy of State Highways No. 196 and 471, and Sections A-1, A-2 and A-3 of State Highway No. 245 in Miami County, Ohio. Involves all necessary roadway and borrow excavation; removal of existing pavement; sealing the existing pavement edges; asphalt concrete surfacing; side approaches, mail box turnouts and berm material; drainage structures; and appurtenant work.

CONDITIONS: Contractor to furnish all materials and complete work by Oct. 15, 1945. Rail and highway transportation facilities available. Wage rates are: skilled labor, $1.15 to $1.725 per hour; semi-skilled, 85c. to $1.575; and common, 37½c. to 75c. Bid totals include premium for industrial insurance and cost for maintaining traffic.

BIDS: Only one bid was received March 27, 1945, the contract low of $137,944 from Fenton Construction Co., Ashland, Ohio. Engineer's estimate was $138,310.

Part A

Item	Quan.	Unit Prices	
		(1)	(2)*
1. Roadway excavation, unclassified	2.904 c. y.	$1.25	$1.00
2. Borrow (contractor to furnish)	5,000 c. y.	1.50	1.00
3. Borrow, using No. 7 screenings (Sect. M-2.7) or granulated slag (Sect. M-3.12)	340 c. y.	2.60	3.60
4. Remove and dispose of exist. pavmt	200 s. y.	1.00	.60
5. Sealing (only) existing pavmt. edge	44.399 l. f.	.03	.025
6. Asphaltic concrete base course	1,083 c. y.	10.30	11.20
7. Asph. conc. leveling course	5,231 c. y.	10.30	10.80
8. Bitum. prime coat AE-3 Sect. M-5.12, including sand cover	7,302 gal.	.18	.15
9. Asphaltic conc. surf. course, Type A	3.041 c. y.	10.30	10.50
10. 1½-in. insulation course	13,000 s. y.	.14	.20
11. Side approaches, mail box turnouts and berm material	976 c. y.	2.50	2.70
12. Guard rail removed and rebuilt	874 l. f.	1.25	.80
13. Stone underdrain (French drain No. 2)	1,800 l. f.	.20	.30
14. Remove and dispose of tops from exist. 12x12-in. concrete posts	117 ea.	.50	1.00
15. Premium on industrial insurance	Lump Sum	2,000.00	600.42
16. Maintain traffic, incl. lights, signs, barricades and watchmen (24-hr. service)	Lump Sum	1,560.00	1,640.00

Part B

Item	Quan.	Unit Prices	
		(1)	(2)*
17. Roadway excavation, unclassified	15 c. y.	2.00	1.50
18. Remove and dispose of exist. bitum. concrete pavement	157 s. y.	.50	.50
19. Remove and dispose of exist. brick pavement	214 s. y.	.75	1.00
20. Remove and dispose of exist. brick wearing course	180 s. y.	.75	.60
21. Remove and dispose of exist. rock asphalt wearing course	3.085 s. y.	.25	.35
22. Remove and dispose of exist. concrete base	100 s. y.	1.50	.50
23. 1½-in. insulation course	461 s. y.	.40	.40
24. Asphaltic concrete leveling course	752 c. y.	10.70	10.20
25. Asphaltic concrete base course	64 c. y.	10.70	11.00
26. Bitum. prime coat AE-3 Sect. M-5.12, including sand cover	1,452 gal.	.18	.17
27. Asph. conc. surf. course, Type B	520 c. y.	10.70	10.50
28. Reset manhole castings to grade	26 ea.	20.00	30.00
29. Reset water valve boxes to grade	8 ea.	15.00	8.00
30. 12x18-in. concrete header	100 l. f.	1.50	1.50
31. Premium on industrial insurance	Lump Sum	300.00	107.61
32. Maintain traffic, incl. lights, signs, barricades and watchmen (24-hr. serv.)	Lump Sum	300.00	550.00

* *Engineer's estimate.*

BRIEF NEWS

President Manuel Avila Camacho of Mexico has ordered the Tequizquiac Tunnel, under construction for several years to relieve Mexico City of peril from flooding during the rainy season, to be completed on Nov. 20.

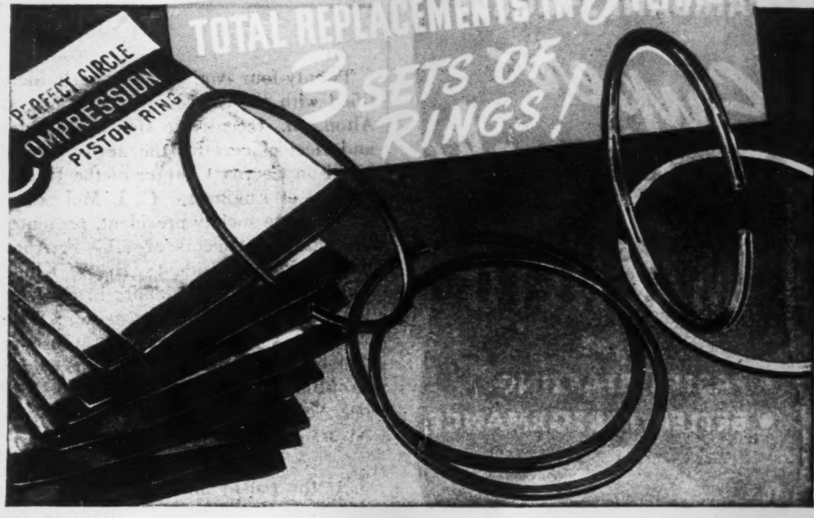
After months of argument, the city council of Cleveland, Ohio, has decided to abide by a War Department order and authorize the removal of the lower Main Avenue Bridge as a menace to navigation. The work will cost about $50,000. The War Department's Great Lakes Division engineer has recommended federal financial aid in the cost of widening railroad bridges over the navigable portion of the Cuyahoga River. City and federal governments have completed most of the river-widening program.

Governor Dwight H. Green of Illinois has signed a bill appropriating $200,000 to the Department of Public Works and Buildings to be spent independently by this department or in cooperation with the United States Government for engineering investigation, surveys, and plan preparation for flood control and water conservation, the design of all needed structures, and the review of plans submitted by the federal government for proposed navigation and flood control works on all water courses and watersheds of the state.

There is need for at least 3,000 new dwelling places in Halifax, N. S., according to G. T. Bates, executive secretary of the Civic Planning Commission. He said there are about 400 acres of land available for housing construction in the Nova Scotia city, which has the largest average population density per acre in Canada.

Mayors of leading cities in Canada, meeting in Toronto recently, urged the setting up of a national reconstruction board, with regional reconstruction boards in each of the nine provinces. It was reported that Canadian municipalities have postwar projects of $45,000,000 at the blueprint stage, $52,000,000 worth of work which could be brought to that stage quickly, and at least $250,000,000 worth of work which could be planned for civic action with proper assistance.

Oregon state voters, in a special election recently approved a $10,000,000 building fund for state institutions. The work will be financed by surplus income-tax revenue. In a municipal election on the same day, Portland rejected a proposal for a $5,000,000 civic center.



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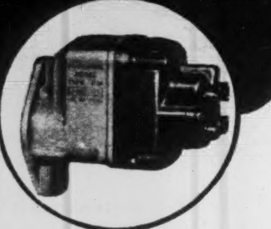

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Elections and Activities

Twenty-four engineers formerly identified with the St. Clair Society met at Alton, Ill., recently to sign the charter and elect officers for the newly formed Madison County Chapter of the Illinois Society of Engineers. C. J. McLean of Dixon, state society president, presented the charter. Officers are: C. F. Abraham, Alton, president; H. A. Kluge, Collinsville, vice president; L. E. Ozier, Wood River, secretary-treasurer; E. J. Wade, Granite City, chapter representative on state board of directors; J. F. Cronlin, Edwardsville, R. Frank Hollis, Alton, and W. Clark Root, Wood River, executive committee.

At the recent annual meeting of the American Congress on Surveying and Mapping in Washington, D. C., Commander Frank S. Borden, of the U. S. Coast and Geodetic Survey was elected president. Maj. Richard T. Evans secretary-treasurer, and A. L. Shalowitz editor of *Surveying and Mapping*, the quarterly journal of the Congress. The meeting included a panel discussion on "Co-operation Among the Technical Organizations," in which representatives from the American Society of Civil Engineers, the American Society of Photogrammetry, the American Geophysical Union, and the American Congress on Surveying and Mapping participated.

The Congress on Surveying and Mapping was organized in 1941 to advance the sciences of surveying and mapping, to contribute to public education in the use of maps, and to encourage the promotion of basic mapping programs.

Frank H. Brant, engineer with the N. C. State Highway & Public Works Commission, Raleigh, N. C., has been elected secretary of the Raleigh Engineers Club. He succeeds R. C. Kirk who is now field engineer with the Kyle Corporation, Atlanta.

Surplus property disposal, anticipated public lands legislation, and the secondary road program were the chief topics of discussion at a 3-day conference of officers and committee members of the National Association of County Officials in Washington, D. C., recently. Delegates listened to Rep. J. Will Robinson of Utah, chairman of the House Committee on Roads, and Thomas H. MacDonald, Commissioner, Public Roads Administration, both of whom spoke on federal highway aid for county roads; Rep. Jennings Randolph of West Virginia who spoke on postwar aviation; Rep. J. Hardin Peterson of Florida, chairman of the House Committee on Public Lands, who discussed anticipated public lands legislation; and Col. Edward H. Heller, of the Surplus Property Board. Other officials participating were George H. Field, Commissioner of Community Facilities, Federal Works Agency; Maj. Jonas Reiner, Deputy Administrator, Surplus Property Board; Arthur G. Eaton, Director, Government Bureau of War Production Board; and Lee W. Moran, Director, Automotive Division, Office of Surplus Property, Department of Commerce.

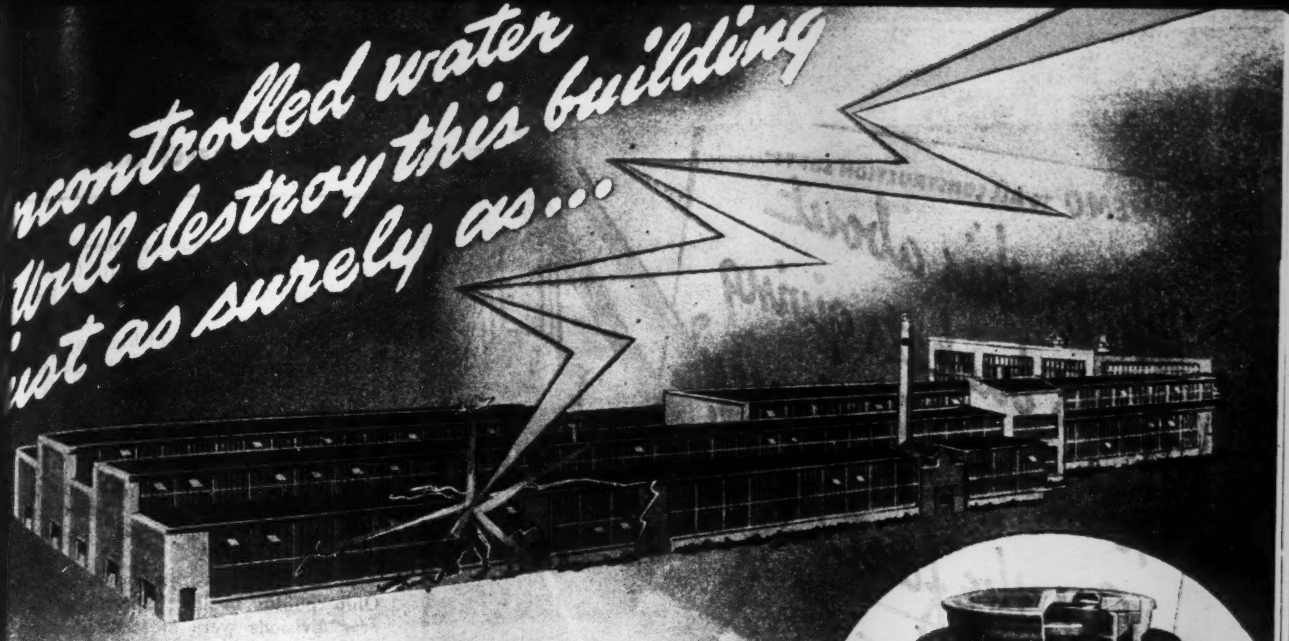
FRANK JARDINE has been made manager of the development division of the Aluminum Co. of America in Cleveland, Ohio; John R. Willard has been put in charge of the sales development division at New Kensington, Pa., and B. J. Fletcher has been appointed chief engineer of the New Kensington branch.

* * *

The City Council of Houston, Tex., has voted to sell at once the entire recently voted $14,000,000 worth of water bonds instead of selling them over a period of years. Net revenue from the Houston water system will be used to pay for the bonds. The first payment on the principal will be $420,000 in 1947. Payments will increase to $753,000 in 1969. After five years Houston can call the bonds by paying par value, accrued interest and a premium of 3 percent, and after seven years, by paying par, accrued interest and 1½ percent premium, while after ten years, it can call the bonds by paying par, accrued interest and no premium.

* * *

Baltimore, Md., will pay Carroll County $50,000 to cover all possible loss of taxes and damages to county property that may be incurred in the building of the proposed municipal reservoir on the Patapsco River. The advance settlement, recommended by the Public Improvement Commission, has been approved by the Board of Estimates "on condition that there be obtained a release of all claims of every nature of any loss of taxes or other damages done by the city heretofore or hereafter in the acquisition of property and the location of the proposed dam and watershed in Carroll County, including any damage caused by relocation of any highways or structures."



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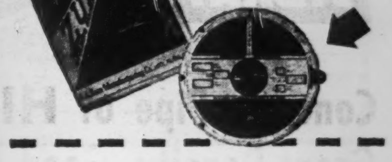

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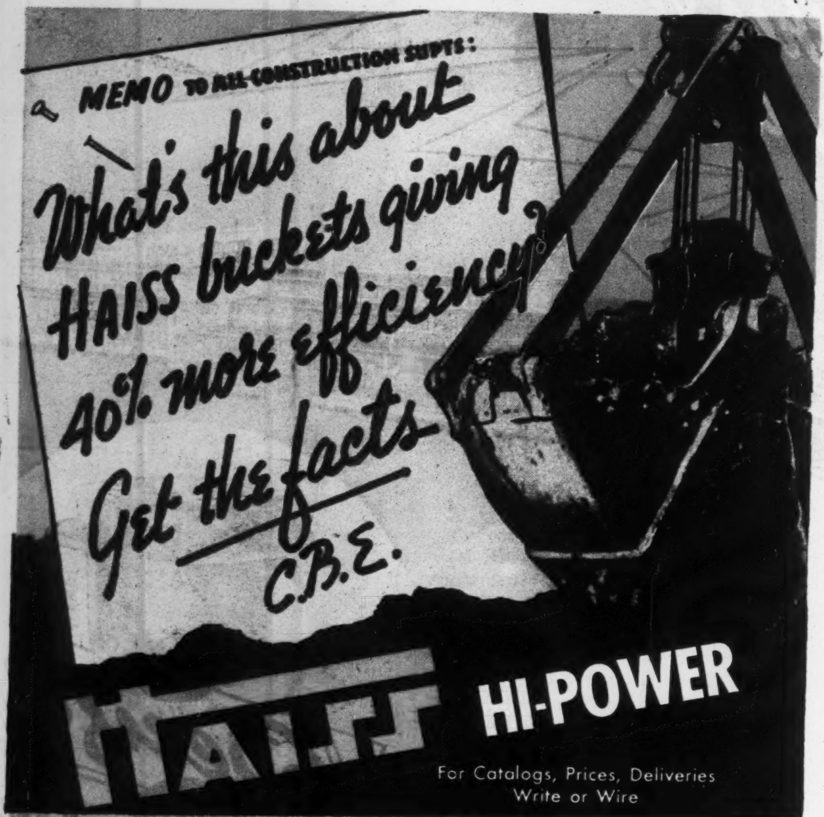
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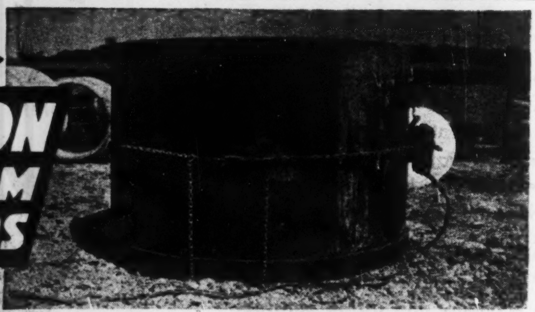

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The Improved, Heavy Duty Model PTV-21A — for use on pipe forms from 36" to 120" diameters, 110-130 volt or 220 volt, 3 phase, 50-75 cycle, 3000 to 4800 V.P.M. Other models for smaller pipe.

JACKSON Vibratory Concrete Pipe Vibrators enable their users to fully meet the increasingly exacting specifications for impermeability and compressive strength; to produce stronger concrete with less cement (as less water is used). Slumps of 1" and lower are readily placed. Spading or puddling costs are greatly reduced. Forms can be stripped earlier and reinforcing steel accurately held in position. Finest pipe can be made adjacent to pipe line construction effecting important savings in transportation costs. Recommendations for practicing the VIBRO-CAST method with JACKSON Pipe Machines are yours for the asking.

Internal and external vibrators for all types of concrete construction.

ELECTRIC TAMPER & EQUIPMENT CO.
LUDINGTON MICHIGAN

Men and Jobs

Howard C. Antrim has been named county engineer of Wyandotte County, with headquarters at Kansas City, Kan.

C. B. Croasdale, chief highway engineer of the New Brunswick, Canada, highways, has retired after 26 years of service.

Roy S. Ridge has been named district paving engineer in the sixth highway district, the Pennsylvania department of public works announced.

In a recent reorganization of the Ohio public health department, five new divisions were created, including a division of sanitary engineering headed by **F. H. Waring,** of Columbus.

Lt. Col. L. V. Bean has returned to his post as city manager of Waycross, Ga., after serving with U. S. Army Engineers since July, 1941.

Joe B. Martin, Nebraska highway department engineer of Norfolk, has resigned.

Jed N. Robinson, former assistant district Texas state highway engineer at Tyler, Tex., has been made state construction engineer with headquarters at Austin, Texas.

James J. Gass of Philadelphia has resigned as engineer for the Pennsylvania State Highway Department's district at Ardmore.

E. I. Rogers, president of the Peoria and Pekin Union Railroad, Peoria, Ill., since 1929, and formerly chief engineer for the company, has announced his retirement.

Sam Anderson has been named county engineer of Bourbon County, Kan., with headquarters at Fort Scott.

R. L. Croasdell was appointed Duval County Zoning and Planning Commission engineer in Jacksonville, Fla., recently. He had been in private engineering practice, and was formerly assistant to the county engineer.

Appointment of **N. B. Garver** as chief engineer of the Arkansas Highway Department is announced. Garver has served as the department's bridge engineer since 1921. Once a designer for the American Bridge Co., Mr. Garver also served as instructor and associate in civil engineering at the University of Illinois from 1910 to 1918.

Jenkins PRACTICAL PIPING LAYOUTS 3

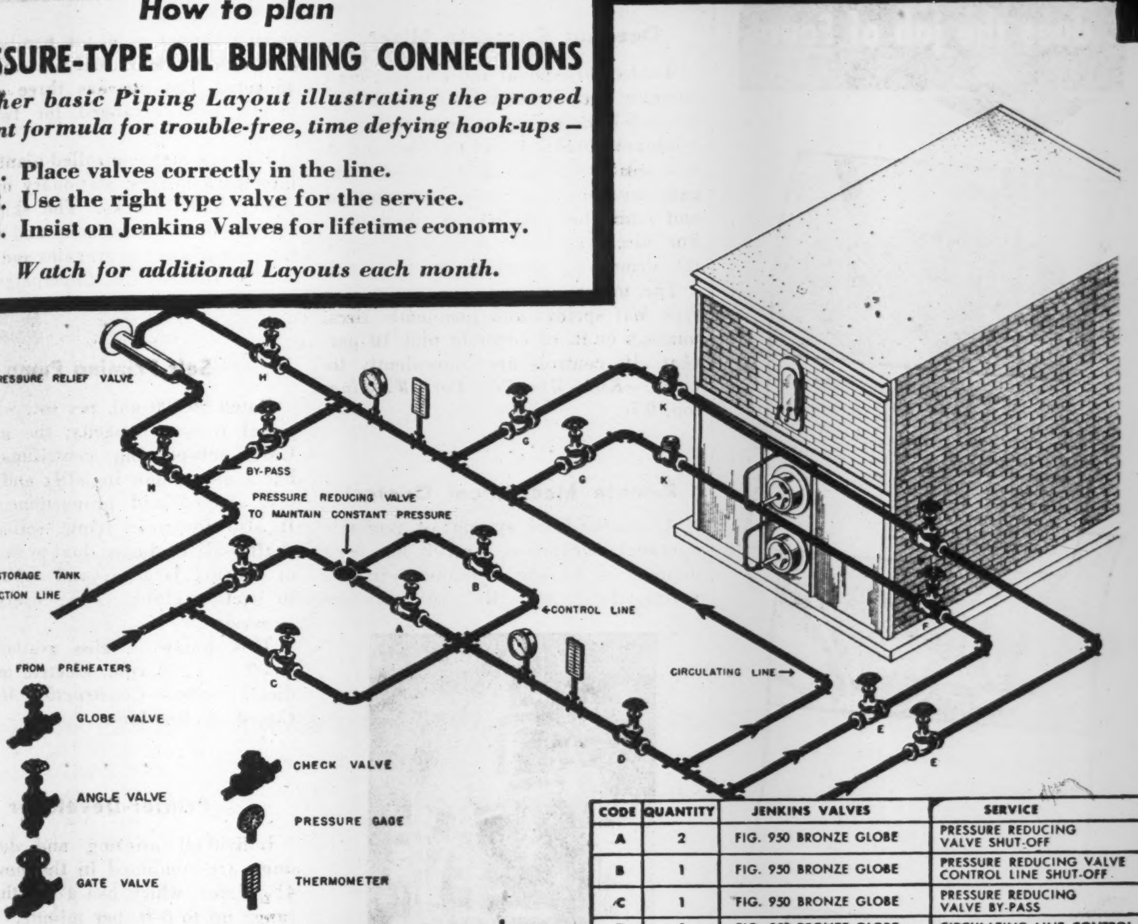
How to plan

PRESSURE-TYPE OIL BURNING CONNECTIONS

Another basic Piping Layout illustrating the proved 3-point formula for trouble-free, time defying hook-ups –

1. **Place valves correctly in the line.**
2. **Use the right type valve for the service.**
3. **Insist on Jenkins Valves for lifetime economy.**

Watch for additional Layouts each month.



VALVE RECOMMENDATIONS

For details—and valves to suit varying conditions—see Jenkins Catalog.

CODE	QUANTITY	JENKINS VALVES	SERVICE
A	2	FIG. 950 BRONZE GLOBE	PRESSURE REDUCING VALVE SHUT-OFF
B	1	FIG. 950 BRONZE GLOBE	PRESSURE REDUCING VALVE CONTROL LINE SHUT-OFF
C	1	FIG. 950 BRONZE GLOBE	PRESSURE REDUCING VALVE BY-PASS
D	1	FIG. 950 BRONZE GLOBE	CIRCULATING LINE CONTROL
E	2	FIG. 950 BRONZE GLOBE	BURNER SHUT-OFF
F	2	FIG. 741G BRONZE NEEDLE FIG. 950 BRONZE GLOBE	BURNER REGULATOR
G	2	FIG. 950 BRONZE GLOBE	CIRCULATION CONTROL AND SHUT-OFF
H	2	FIG. 950 BRONZE GLOBE	PRESSURE RELIEF VALVE SHUT-OFF
J	1	FIG. 950 BRONZE GLOBE	PRESSURE RELIEF BY-PASS
K	2	FIG. 830 BALL CHECK FIG. 756 REGRINDING LIFT CHECK	BACK-FLOW PREVENTION

SYSTEMS USING STEAM to preheat oils, fired under pressure, are in wide use today. This layout is arranged for the multiple-burner type boiler. In the event of oil leaks or other failure, the valves are arranged to provide flexibility of shut-offs. To prevent complete boiler shutdowns in an emergency, by-passes are provided around the pressure reducing or relief valves. Constant and uniform oil pressure is maintained by an automatic regulating valve.

MANY PATTERNS AND PRESSURE RANGES of Jenkins Valves, other than those indicated, can be used for a layout of this type, according to the particular installation. Consultation with accredited piping engineers and contractors, when adapting these suggestions to your own requirements, or when planning any major piping installations, is recommended.

COPIES OF THIS LAYOUT, enlarged with details of valve specifications, also future "Piping Layouts" as they appear, will be sent at your request.

SELECT THE VALVES you need from one source, and save time and trouble. The Jenkins catalog lists over 600 different patterns. With rare exceptions, you will find just the valves you want . . . made by Jenkins valve *specialists* – your assurance of the lowest cost in the long run.

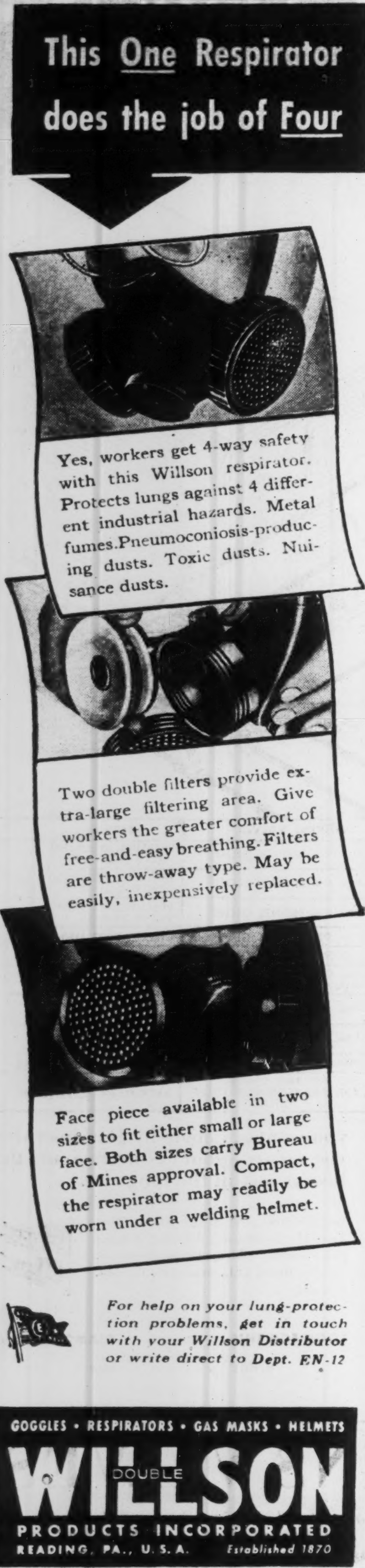
Jenkins Bros., 80 White Street, New York 13; Bridgeport; Atlanta; Boston; Philadelphia; Chicago; San Francisco. Jenkins Bros., Ltd., Montreal; London, England.

LOOK FOR THIS DIAMOND MARK
SINCE 1864

JENKINS VALVES

For Domestic, Commercial, Engineering and Industrial Service . . . In Bronze, Iron, Cast Steel and Corrosion-resisting Alloys . . . 125 to 600 lbs. pressure.

Sold Through Reliable Industrial Distributors Everywhere


This One Respirator does the job of Four

Yes, workers get 4-way safety with this Willson respirator. Protects lungs against 4 different industrial hazards. Metal fumes. Pneumoconiosis-producing dusts. Toxic dusts. Nuisance dusts.

Two double filters provide extra-large filtering area. Give workers the greater comfort of free-and-easy breathing. Filters are throw-away type. May be easily, inexpensively replaced.

Face piece available in two sizes to fit either small or large face. Both sizes carry Bureau of Mines approval. Compact, the respirator may readily be worn under a welding helmet.

For help on your lung-protection problems, get in touch with your Willson Distributor or write direct to Dept. EN-12

GOGGLES • RESPIRATORS • GAS MASKS • HELMETS
DOUBLE
WILLSON
PRODUCTS INCORPORATED
READING, PA., U. S. A. *Established 1870*

New Aids to the Constructor

One-Bag Concrete Mixer

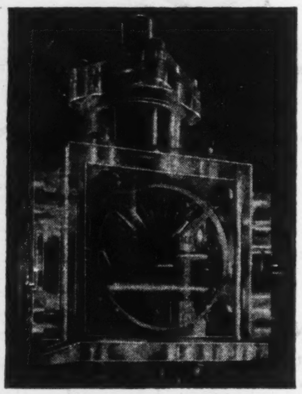
Welded throughout and utilizing high strength steel extensively, a new Kwik-Mix 6-5 Dandie one-bag concrete mixer combines durability and light weight. A new selective skip shaker does not engage until the skip is partially emptied and ready for shaking. A tilted flowline discharge chute is said to empty the drum very quickly.

The mixer, balanced on automotive type leaf springs and pneumatic tires, mixes 6 cu.ft. of concrete plus 10 percent. Its controls are conveniently located.—*Kwik-Mix Co., Port Washington, Wis.*

• • •

Remote Mechanical Control

A standardized system of remotely operated mechanical controls has been announced, for use on cranes, winches, valves, doors, etc. Related units are suitable for power operation under speeds not exceeding 1,800 rpm.



There are two standard types of Steady Shaft assembly—one for attachment to surface square to the shaft; the other to surface parallel to the shaft. All shaft ends are interchangeable in the Spiral Bevel Gear assembly. The Universal Shaft assembly is made in lengths ready to be installed or with one end-yoke to be field welded after the tube is cut.—*M. L. Bayard & Co., 1923 Indiana Ave., Philadelphia 32, Pa.*

• • •

Batching Plant

Operating on any level area near the pouring site, the new Porto Batcher may be easily towed by truck from job to job. No pit nor foundation is required, nor is a crane necessary for handling aggregates or setting up the plant, which has a 5 cu. yd. truck receiving hopper, a 90 ton per hr. aggregate elevator and total bin capacity of 45 tons. The bin has three compartments, each arranged for two truck loads.

This one-man-controlled plant batches into truck mixers, stationary mixers or power batch trucks. The skip allows full use of mixer capacity and thorough intermingling of aggregates and cement. —*C. S. Johnson Co., Champaign, Ill.*

• • •

Self-Priming Pump

Rated 90,000 gal. per hr., with additional reserve capacity, the new 6-in. CMC self-priming centrifugal pump has a mixed flow impeller and a properly shaped and proportioned volute. It also features: triple self-adjusting shaft seal; exclusive dual-prime method of priming large ground shafts; built-in suction check valve; oversize ball bearings.

This pump is also available with 1,800 to 1,200 rpm. electric motors or diesel engine.—*Construction Machinery Co., Waterloo, Iowa.*

• • •

Printer-Developer

Individual printing and developing units are combined in the new Model 41 printer, which has a printing speed range up to 6 ft. per minute. It prints either roll stock or cut sheets 46 in. wide. The light is provided by a 2,000-watt glass mercury vapor lamp in a 6-in. dia. cylinder, and the units are enclosed in a steel frame cabinet of box girder construction, mounted on casters. A new method of cooling pulls air

ANNOUNCING
Careylastic

hot-poured rubber compound for sealing joints in concrete paving and construction

NO YEARLY MAINTENANCE as required of ordinary joint seal that extrudes and breaks down under extreme temperatures.

MEETS SPECIFICATIONS — Federal Spec. SS-F-336; C. A. A. Spec. P-605 and State Highway Departments using rubber joint seal.

Careylastic prevents infiltration of water and moisture through cracks, crevices and joints. It is made from a tested formula that conforms to specifications of the Army, Navy, Civil Aeronautics Administration and State Highway Departments in every respect.

It is recommended for use in street and highway paving, airfields, bridges, buildings, sidewalk skylights, reservoirs and pools—in fact wherever concrete structures require sealed joints.

Careylastic is available in 80 lb. bags. For price and data on installation consult your nearest Carey Branch, or write—

EXTENSIBLE and maintains perfect bond in excess of requirements at low and high temperatures.

1945 1915

30 YEARS OF EXPERIENCE in the manufacture of expansion joint materials stand behind the development of Careylastic.

HE PHILIP CAREY Carey MANUFACTURING CO.

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OFFICE AND FACTORY: LENNOXVILLE, P. Q.

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ilt-up Roofing • Roof Coatings and Cements • Waterproofing Materials • Asphalt Tile Flooring • Pipeline Felt
pansion Joint • Asbestos Wallboard and Sheathing • Corrugated Asbestos Roofing and Siding • Miami-Carey Bathroom Cabinets and Accessories

A GOOD BRIDGE TO CROSS

Before you Build

Head off the hazards of decay and termite attack. Pressure-treat wood with Wolman Salts* preservative before you build. That's excellent life insurance for all wood structures—this bridge, for example.

A *Proven Treatment*

Wolmanized Lumber*—millions and millions of feet—has proved its lasting ability throughout the past quarter-century. That's why it was specified for so many Army and Navy structures all over the world.

After the War

There'll be an abundance of wood for all construction. Even now, lumber and timber are available for rated construction projects. Retain these advantages by building with wood—low cost, faster erection, high insulating value, light weight, resilience—and add long life. Specify Wolmanized Lumber.

AMERICAN LUMBER & TREATING COMPANY

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*Registered trademarks

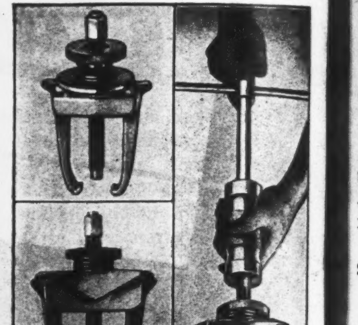
1649 McCORMICK BUILDING, CHICAGO 4, ILLINOIS

into and through the cylinder and contact bands; air is also sucked in at the front of the machine, for greater operator comfort and maximum cleanliness.—*Charles Bruning Co., Inc., 475 Montrose Ave., Chicago, 41, Ill.*

• • •

Matched Gear Pullers

Covering a wide range of pulling utility, a new series of matched gear puller is available with maximum jaw capacities of 4½, 8½ and 14 in. The smal and medium sizes are also available i



slide-hammer design, or equipped fo use as either standard or booster hammer pullers.

All models have the same yoke an jaw construction, with a powerful spring controlled jaw lock. Because o its long jaw the puller is effectiv where the shaft extends some distanc through the gear. On the slide hammer model, the centralized, guided shock of the booster hammer, plu screw tension, is said to provide grea pulling force.—*Snap-On Tools Corp. Kenosha, Wis.*

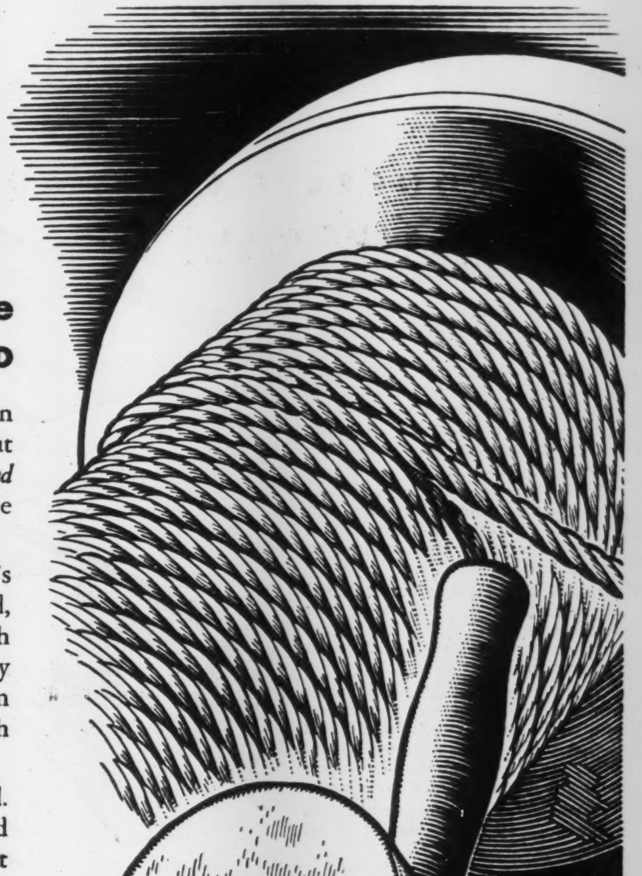
• • •

Electrical Repair Kit

One hundred solderless terminals o the most-used types for wire sizes 2 to 10 are supplied with a new, inexpensive electrical repair kit, which also includes ring tongue, line splice, butt connectors and spade tongue terminals.

The special A-MP tool supplied with the kit has insulated handles of molded plastic and a corrosion-resistant finish. It allows for cutting wire to desired length, has a gage to determine length of insulation to be removed, and permits wire to be inserted in an opening with markings which correspond to wire size.—*Aircraft-Marine Products, Inc. Harrisburg, Pa.*

Uniformity here aids production . . .



EVEN SPOOLING

comes naturally to flexible
PREFORMED YELLOW STRAND

A wire rope that winds tightly and evenly on the drum helps equipment work at capacity. But you might wonder—if you didn't know *Preformed* Yellow Strand—how any line could overcome some common obstacles to good spooling.

The drum itself may be too small. Often there's erratic alignment . . . too much speed for the load, whether light or heavy . . . excessive slack. Such faults can bedevil an unpreformed rope—already burdened by unruliness—into pulling away from the adjoining wrap, climbing back over the high layer or crisscrossing at will.

Not so with limber *Preformed* Yellow Strand. By preshaping wires and strands we've relaxed internal stresses and improved the defense against *external* bends. The line spools uniformly because it takes *naturally* to drum grooves and the channels between rope coils.

The same smooth-running qualities promote sheave efficiency. Slippage and abrasive wear decline. Both rope and parts last longer.

Specify *Preformed* Yellow Strand by name. Get all you should in wire rope performance and economy. Broderick & Bascom Rope Co., St. Louis 15, Mo. *Branches:* New York, Chicago, Houston, Portland, Seattle. *Factories:* St. Louis, Seattle, Peoria.

HAND BOOK FREE: "Industrial Wire Ropes" contains useful facts, tables, pictures. Write for your copy.

BRODERICK & BASCOM
Yellow Strand
PREFORMED WIRE ROPE

HOW TO

improve appearance and save money

ON CONCRETE CURB, GUTTER AND SIDEWALK

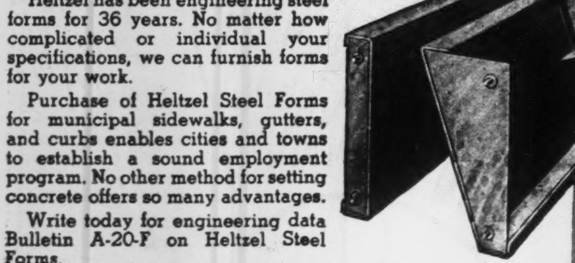
You buy Heltzel Steel Forms once. They stay in service for 20 years or more and each job you set is as uniform as the ones before. The low cost of the equipment per year of service plus the benefits of faster work with the use of forms net substantial savings.

Rigid, self-interlocking Heltzel Steel Forms make the setting and stripping job much easier and faster. No warping, no chipping, no replacements.

Heltzel has been engineering steel forms for 36 years. No matter how complicated or individual your specifications, we can furnish forms for your work.

Purchase of Heltzel Steel Forms for municipal sidewalks, gutters, and curbs enables cities and towns to establish a sound employment program. No other method for setting concrete offers so many advantages.

Write today for engineering data Bulletin A-20-F on Heltzel Steel Forms.



Send me catalog A-20-F
"Steel Forms for Building Concrete Curbs, Curb and Gutters, or Sidewalks"

Name________________________

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(Type of construction usually engaged in)

HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO · U. S. A.

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BUILDS IT BETTER

- BINS, Portable and Stationary
- CEMENT BINS, Portable and Stationary
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- BATCHERS (for batch trucks or truck mixers with automatic dial or beam scale)
- BITUMINOUS PAVING FORMS
- ROAD FORMS (with lip curb and integral curb attachments)
- CURB FORMS
- CURB AND GUTTER FORMS
- SIDEWALK FORMS
- SEWER AND TUNNEL FORMS
- CONCRETE BUCKETS
- SUBGRADE TESTERS
- SUBGRADE PLANERS
- TOOL BOXES
- FINISHING TOOLS FOR CONCRETE ROADS

Manufacturers' Activities

R. W. Blunt has been appointed manager of the Philadelphia district and E. V. Crossin manager of the Pittsburgh district, it has been announced by A. G. Frankenhoff, vice-president and general manager of The Dicalite Co.

R. W. Blunt

Both men were born in Ohio and attended college and university i that state. Befor joining the Dicalite organizatio Mr. Blunt wa with the Kieckhefer Containe Co. in Parkersburg, W. Va., and before that had been with the Ohio Boxboard Co., Rittman, Ohio.

E. V. Crossin

Mr. Crossin's work for the last 13 years has been along engineering lines, with the two firms of A. W. Burns Construction Co., and Columbia Engineering Corp., Columbus, Ohio.

The Insley Manufacturing Corp., Indianapolis, Ind., has appointed Louis R. Russell Chie engineer of th crane and shove division, in charg of research, desig and developmen A native of Kansas, he has a background of 38 year experience in design engineerin with other leadin shovel companies, including Erie, Bucyrus-Erie, Koehring and Marion.

He has designed and developed shovels and cranes from $\frac{1}{2}$-yd. to 12-cu yd. capacities, powered by steam, gasoline, diesel and electric power plant

His appointment will permit Frederick B. Ray, chief engineer of th concrete equipment division and a specialist in that line during his 25 year with Insley, to devote all his time

GETTING A 225,000-gpm PUMP OFF TO AN *Easy Start*

Here's a case where G-E engineers were called in to recommend a motor *tough enough* to drive a vertical pump delivering 225,000 gallons of water a minute, yet *gentle enough* to start without disturbing the power supply. They specified a synchronous motor that not only met the requirements exactly, but also enhanced the appearance of the station.

This storm-water project required nine pumps, each rated 225,000 gpm at a 25-ft head. Motor horsepower aggregated 18,000, yet the power-supply conditions ruled out excessive current surges and voltage disturbances. Motors for driving vertical pumps had to be started smoothly and accelerated smoothly with low starting currents.

G-E engineers recommended synchronous motors, each rated 2000 hp, 240 rpm. These motors were designed for part-winding starting. The chart shows why this was done. By starting the motor on part of the complete winding, the starting current and torque are significantly reduced. After a time interval, during which the power supply adjusts itself, the rest of the winding is energized. Starting is thus accomplished without opening the circuit, or otherwise creating excessive current surges at the transfer point.

Current increment at the transfer point is less than 250 per cent of the rated full-load current; maximum current during accelerating and synchronizing is less than 550 per cent. In less than 60 seconds, motor, pump, and water are accelerated from standstill to, and including, synchronization.

SMOOTH STARTING WITH PART WINDING

This installation emphasizes the benefits of the synchronous motor arranged for part-winding starting. Control equipment is highly simplified. Acceleration is smooth, because the power circuit to the motor is not opened during the starting period. Even when high-current-interrupting capacity is required, simplicity of control is maintained.

If you are faced with an unusual problem in matching motor performance with pumping requirements, a synchronous motor with part-winding starting may be the answer. It will pay you to consult G-E engineers about special pumping problems. *General Electric Company, Schenectady, New York.*

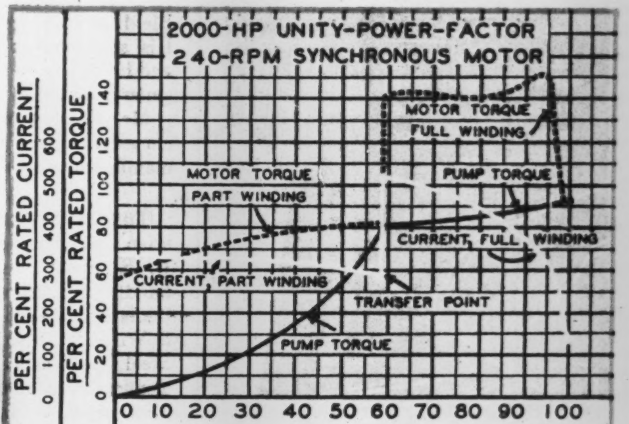
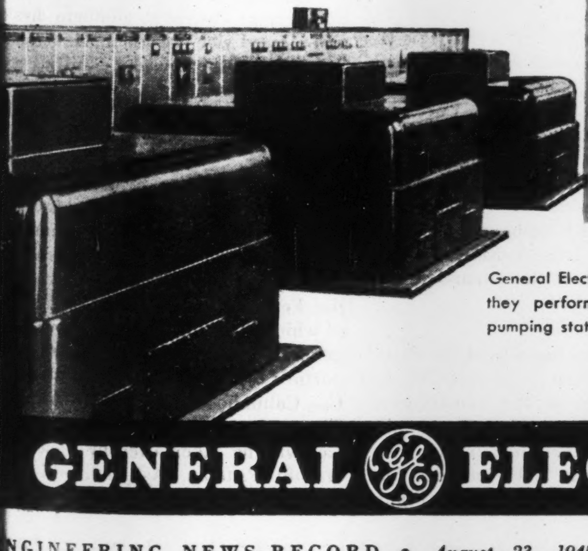


Chart of the starting characteristics of the G-E 2000-hp, unity-power-factor, 240-rpm synchronous motor arranged for part-winding starting.

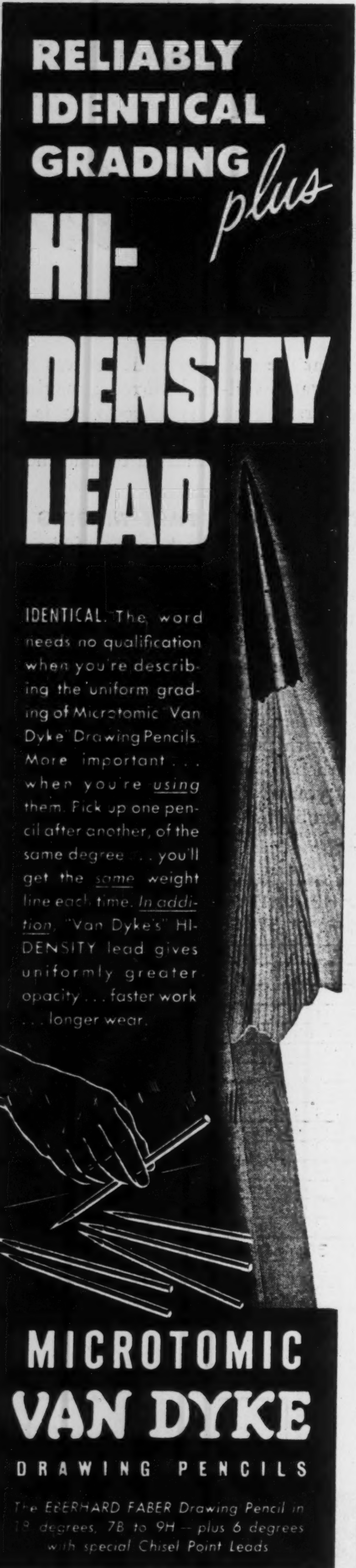
BUY WAR BONDS



General Electric motors look as well as they perform. They "dress up" any pumping station.

SYNCHRONOUS MOTORS

GENERAL ELECTRIC


RELIABLY
IDENTICAL
GRADING *plus*
HI-
DENSITY
LEAD

IDENTICAL. The word needs no qualification when you're describing the uniform grading of Microtomic "Van Dyke" Drawing Pencils. More important . . . when you're *using* them. Pick up one pencil after another, of the same degree . . . you'll get the *same* weight line each time. *In addition*, "Van Dyke's" HI-DENSITY lead gives uniformly greater opacity . . . faster work . . . longer wear.

MICROTOMIC
VAN DYKE
DRAWING PENCILS

The EBERHARD FABER Drawing Pencil in 18 degrees, 7B to 9H — plus 6 degrees with special Chisel Point Leads

research and development. The line, developed under the supervision of Mr. Ray, includes readymix concrete buckets, floor and receiving hoppers, rocker and standard dump hand carts and roller hoist buckets. Early in July the company delivered its first excavator to a civilian buyer since 1942.

"I Dub thee B9," said John Kimball, director of the Mississippi Agriculture and Industrial Board, as he smashed a bottle of Mississippi river water on the nose of a new 150-horsepower Tournapull tractor. It was the christening recently of the state's No. 1 product designed for postwar construction—a rubber-tired prime mover designed primarily for use with LeTourneau dirtmoving machines and cranes. The tractor, the first ever built on a production line in the state, was "launched" at the LeTourneau plant near Vicksburg. The machine was the first of a pilot lot, designed for civilian consumption.

L. V. Denniston has been appointed manager of the building products division of Adams & Westlake Co., succeeding Ward Kessler, resigned, Wilson A. Smith, president, announces.

Mr. Denniston has been associated with the estate of Marshall Field for 14 years. His appointment was effective July 1, and he will be in the Adams & Westlake general offices at Elkhart, Ind.

Mr. Kessler resigned to organize a corporation that will shortly enter the manufacturing field at Bristol, Ind.

The Tennessee Coal, Iron & Railroad Co., Birmingham subsidiary of the U. S. Steel, has been designated to handle the sales of the Carnegie-Illinois Steel Corp. and American Steel & Wire Co., also subsidiaries of U. S. Steel, in North and South Carolina, Tennessee, Alabama, Georgia, Florida, Mississippi, Louisiana, Arkansas, Texas and Oklahoma, as announced jointly by the three companies. M. H. Geisking, vice president and manager of sales, Tennessee Coal, Iron & Railroad Co., will be in charge of the expanded territory.

John Gronlund has joined the Pettibone Mulliken Corp., Chicago, Ill., as director of sales in the construction equipment division. Mr. Gronlund's many years of experience in the construction equipment field includes former connections with the LaPlant-Choate Co. and the Buckeye-Traction Ditcher Co.

The products that will receive his special attention are shovel dippers, pullshovel dippers, drag line and clamshell buckets. Pettibone Mulliken is now in full volume production on these four items and it is planned to stock popular sizes for prompt delivery.

Harry L. Vines has been named director of sales for Tyson Bearing Corp., Massillon, Ohio. Formerly western manager for R. G. LeTourneau, Inc., Stockton, Calif., he had sales management experience with Master Equipment Co. and Caterpillar Tractor Co., before joining LeTourneau.

C. E. Lovewell, formerly service engineer for the Louisville Cement Co. of Kentucky, has joined the Carney Co. of Minneapolis and Mankato, Minn. He takes over as chief engineer and director of research with offices in Minneapolis. The company manufactures natural and masonry cement.

Marion Steam Shovel Co., Marion, Ohio, has appointed Azel W. Hedberg, Cleveland, as works manager. He was St. Clair division manager of the Parker Appliance Co., Cleveland. He also has been associated with General Motors Corp., Republic Steel Corp. and Briggs Manufacturing Co.

J. C. Rowold, vice president of Mack-International Motor Truck Corp., has been appointed manager of the Pacific Coast division, according to announcement made by A. C. Fetzer, Mack vice president. Mr. Rowold replaces J. A. Stoner who has retired after 28 years of active service. Mr. Rowold joined the general sales department in 1917 and within 10 years had worked his way up through a variety of sales positions to district manager in the southern division. Seven years later he was named manager of the entire southern division and elected vice president. He remained manager of the division until his present appointment. He will be at 1501 South Central Avenue, Los Angeles, Calif.

Ralph Bowsman, owner of the Bowman Washed Sand and Gravel Co., Troy, Ohio, has sold his road contracting equipment and road material producing plants at Troy, Piqua, and Urbana t the Fenton Construction Co., Ashland, of which Harry B. Fenton, Lakewood, general manager. The latter was partner of the Ohio Road Improveme Co., Columbus, from 1933 through 194 The entire personnel of the Bowsma Co. will be taken over by Fenton a Harold Pittman, Ashland, will be charge.

This Youngstown Alloy Link

Holds a 45,000-ton Battleship on Leash

In few services does steel take more punishment than in an anchor chain. Wind and tide tug at it, keep links rubbing against each other, keep bottom sand cutting its surfaces. It must stand strain and shock, resist corrosion and abrasion. It must hold its vessel securely in roughest water.

This die-lock link, forged from tough alloy steel bar stock, is a triumph of engineering design and manufacture over Nature. Product of the Boston Navy Yard, made of standard alloy, this link is much lighter in weight, yet far stronger, than other types of ordinary iron and steel. It uses less steel and makes a better, much longer lived chain, abrasion resistant, an excellent leash for even our big 45,000-ton battleships.

Having proved its ruggedness in anchor chains for the Navy, Youngstown Alloy Steel is ready to serve in your toughest jobs. It is furnished to standard specifications. Your inquiry is invited.

QUALITY YOUNGSTOWN SERVICE

YOUNGSTOWN

THE YOUNGSTOWN SHEET AND TUBE COMPANY

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Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

Pipe and Tubular Products - Sheets - Plates - Conduit-Bars-Coke Tin Plate-Electrolytic Tin Plate-Rods-Wire-Nails-Tie Plates and Spikes

Air Express gets
New Truck in Production
weeks Faster

When the Army orders new equipment — a truck, for instance — things move at breakneck speed. Blueprints, specifications and material specimens shuttle back and forth. Then come tools, jigs, dies. And it's mostly done at 3-mile-a-minute speed via Air Express.

Getting peacetime civilian products to market will also have the same kind of urgency. There's not only competition to meet but payrolls and overhead, too. Air Express is a money-saver because it's a time-saver. It is one of the most versatile of all industrial tools. It will pay you to investigate its use and economy in your business — whatever business you're in.

Specify Air Express-a Good Business Buy

Shipments travel at a speed of three miles a minute between principal U. S. towns and cities, with cost including special pick-up and delivery. Same-day delivery between many airport towns and cities. Rapid air-rail service to 23,000 off-airline points in the United States. Direct service to scores of foreign countries.

AIR MILES	2 lbs.	5 lbs.	10 lbs.	25 lbs.
250	$1.04	$1.25	$1.57	$2.63
500	$1.11	$1.52	$2.19	$4.38
1000	$1.26	$2.19	$3.74	$8.75
2500	$1.68	$4.20	$8.40	$21.00

AIR EXPRESS

AIR EXPRESS

GETS THERE FIRST

Write Today for interesting "Map of Postwar Town" picturing advantages of Air Express to community, business and industry. Air Express Division, Railway Express Agency, 230 Park Avenue, New York 17. Or ask for it at any Airline or Express office.

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Manufacturers' Publications

Welder's Guide—A 32-page pocket-size booklet is a guide for hard facing of metals accomplished by the welding of a layer of hard, wear-resistant metal to the surface of softer metal to increase resistance to wear from abrasion and impact.—*Mir-o-col Alloy Co., 2416-60 East 53d St., Los Angeles 11, Calif.*

Mine, Quarry and Gravel Pit Equipment—A handsome booklet describes jaw and roll crushers, feeders, conveyors, troughing idlers, screens, and sand dehydrators. — *Pioneer Engineering Works, Minneapolis 13, Minn.*

Finishing Screed—A folder describes a new vibrating principle in a concrete finishing screed, which it is claimed, speeds up concrete placing, improves finishing and saves cement—*Master Vibrator Co., Dayton, Ohio.*

Masonry Saws—A complete compilation of cutting information is contained in a booklet by a manufacturer of saws that will cut any masonry material no matter what the degree of hardness.—*Clipper Manufacturing Co., St. Louis 10, Mo.*

Insulating Brick—Valuable charts are contained in this catalog of five insulating bricks of importance to refractories users.—*Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh 22, Pa.*

Branch Pipe Outlets—A pocket-size manual illustrates and explains the four steps in installing full pipe strength outlets by this manufacturer's method. It also illustrates the tools needed to make the joint, the three types of fittings available for butt-welded, threaded and socket-welded branch pipes, and it shows typical installations.—*Bonney Forge & Tool Works, Allentown, Pa.*

Tunnel Lining—All tunnel builders will be interested in this 100-page cloth bound book replete with photographic reproductions of typical jobs where concrete was used for tunnel lining. Tunnel contractors and engineers can be assured that the various methods and procedures described in this book have been accepted as sound practice for the conditions given in each instance. Some of the material used is from the files of *Engineering News-Record* and *Construction Methods.* The price of the book is $3.—*Chain Belt Co., Milwaukee.*